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Journal of the Society of Arts.

FRIDAY, JANUARY 30, 1857.

CONVERSAZIONI.

The Council have arranged for two *Conversazioni* for the Members of the Society and their friends, the first to take place on Saturday, the 21st of February, to which ladies will be invited; the second on Wednesday, the 6th of May, to which gentlemen only will be invited.

NINTH ANNUAL EXHIBITION OF INVENTIONS.

The Council have fixed Monday, the 23rd of March next, for the opening of the Ninth Annual Exhibition of Recent Inventions.

Persons intending to contribute to the Exhibition should communicate with the Secretary forthwith, stating—

1. The title of the invention.
2. Whether the article will be a specimen, model, or drawing.

Articles for exhibition must be forwarded to the House of the Society, *carriage paid*. The days for receiving articles are, Thursday, the 5th, Friday, the 6th, and Saturday, the 7th of March.

All articles should be accompanied with a short description of the invention, for the Catalogue, with a wood-block (when possible), and a reference to any publication where a fuller account may be found.

EIGHTH ORDINARY MEETING.

WEDNESDAY, JAN. 28, 1857.

The Eighth Ordinary Meeting of the One Hundred and Third Session was held on Wednesday, the 28th inst., W. G. Armstrong, Esq., in the chair.

The following Candidates were balloted for, and duly elected members of the Society:—

Beverley, Henry Webber.	Pakington, Rt. Hon. Sir
Dilke, Charles W., jun.	John S., M.P., D.C.L.,
Graham, Forster.	&c.
Gyde, Alfred.	Phillipps, William.
Harvey, James.	Pyper, Rev. Richard.
Hilton, Thomas.	Ryland, Arthur.
Humphreys, Edward Rupert, LL.D.	Smith, Henry Fry, B.A.
Jaffray, Arthur Woodriff.	Thrupp, George A.
Kimber, Thomas.	Trevelyan, Alfred Wilson,
Laurence, George.	A.B.
Lewis, Harvey.	Webb, John.
Lynd, William.	Yelland, Robert Easton.

The Paper read was:—

ON THE APPLICATION OF MACHINERY IN THE WAR DEPARTMENT.

By JOHN ANDERSON, INSPECTOR OF MACHINERY,
ROYAL ARSENAL, WOOLWICH.

During the last few years important improvements have been made in the manufactories of the War Department. Up to a recent period, by far the greater proportion of the work, in making the munitions of war, was performed by hand labour. In 1842 there were but two steam-engines, together equal to 32 horse-power, which gave motion to a few machines for sawing and planing the timber of gun-carriages. The simple statement that there are now 68 steam-engines, with a nominal power equal to 1,170 horses, giving motion to 16,540 feet of shafting, 18 steam hammers, 64 hydraulic presses, and 2,773 machines of various descriptions, will afford some notion of the extraordinary effort which has been made to render the several establishments thoroughly efficient and fitted for any emergency.

These improvements embrace such a variety of detail that an extremely superficial view only can be given of them, in the short space of time which is allowed me, for I can only hint at great plants of machinery in general terms; but I trust, notwithstanding, to be able to show that the War Department has been thoroughly in earnest, and that the great aim has been to obtain the best apparatus that could be procured.

Without prejudice, the United States of America, the continent of Europe, and our own country, have been searched for the most superior appliances, and hundreds of machines have been designed for purposes peculiar to the War Department, but which may be usefully employed in the general manufactures of the kingdom.

From these important changes and improvements the greater proportion of war stores can now be produced with unskilled labour, the form, dimensions, quality, and quantity of the produce being mostly dependent on self-acting apparatus, a system of operation which has been more fully developed in the wood and metal manufactures of the War Department than in any private establishment with which I am acquainted.

From the completeness of the machinery, and the general arrangement of the plant, the cost of production of the several articles is reduced to a minimum, and there being no pecuniary interest calculated to induce an inordinate desire for saving, either in regard to the quality of the materials employed, or in the amount of workmanship necessary to be expended, there is great security afforded that the several articles are the very best for the purpose which can be made, a most vital consideration in regard to war stores and material, on which may some day depend the fate of battles and the nation's honour.

When the several works now in progress are completed, the Government will be placed in the commanding position of being able to provide the munitions of war, fresh and serviceable, in such abundant profusion as shall be equal to the sudden requirements of any armament they may deem necessary to equip.

Of the more important services to which machinery has been applied by the War Department, a few have been selected for enumeration; these have been chosen either for the extent of their application, or the interest which the meeting is likely to attach to the *class of subject*, commencing with

SMALL-ARMS.

The small-arms manufacture of England, both in the public and private establishments of the country, has not kept pace with other branches of industry, in the application of labour-saving machinery. This has resulted from various causes, partly from the peculiar organisation of the system of hand labour, by which the various parts of the musket have been hitherto produced,

thus rendering it difficult to apply machinery qualified to compete therewith, and which, at the same time would repay the necessary outlay.

The musket being an instrument of considerable refinement, requiring from those who make it a high degree of skill, and an extreme nicety of workmanship in many of its component parts, the obstacles in the way of applying the ordinary machinery of the machine maker are numerous; for although there may appear some resemblance between muskets and small machinery, yet, when compared minutely, the similarity soon vanishes. The forms employed by the machine maker have, with a few exceptions, been simplified into the line, the plane, the circle, the cone, and the sphere, all of which are very easily produced by simple apparatus. The parts of the musket, on the contrary, are of forms so various and nondescript as to call for another description of tools, involving a higher and more advanced state of the arts to insure its successful introduction. The parts of ordinary machinery, although accurate, as compared with the general work of carpenters, still come far short of the precision required in the fabrication of small arms, where the form and dimensions are determined to the thousandth part of an inch.

For the last hundred years, machines, such as the rose lathe, have been made to produce the most refined instruments, so accurate, indeed, that no hand labour could imitate them; but the work is performed so slowly as to render its produce far too costly for the workshop of the gunmaker, who requires a system of apparatus which shall afford the utmost exactness, fully equal to that of the philosophical instrument maker, but which, at the same time, will yield a rate of production equal to that of the more simple and less refined workmanship of the machine maker.

The difficulty of reconciling these two conditions, has hitherto been of so formidable a character, as to have offered a complete barrier to the extensive application of machinery in the manufacture of small arms.

Had the manufacture of muskets been carried on in the same manner as that of machinery, in factories where the several parts of stock, lock, barrel and bayonet, were made under one system of management, the general introduction of refined tools would have been sooner arrived at; but from the constitution of this branch of industry, with the separate parts produced by different masters, and then afterwards collected in the workshops of another master to be there put together, there is little difficulty in arriving at one cause of the limited application of machinery; and all the more so that the prejudices of those engaged in that manufacture were naturally opposed to a system which put their old arrangements to one side, and which demanded a degree of refinement in tools and machinery not to be met with in any extensive manufacture in the kingdom.

Before a manufactory for small-arms could be satisfactorily organised, the world had to undergo a certain course of training. The inventions of Watt and Arkwright led to the manufacture of machinery on the largest scale, while the inventions of Bentham and Brunel contained almost all the essential elements of modern tools, and more especially the germ of the application of machinery to copy intricate forms from a pattern; a principle of operation which has been most successfully developed in the new small-arms manufactory of the War Department.

Although the difficulty of introducing radical changes into the gun trade of the old world, where it has existed for centuries, and where there are obstacles of a traditional and local character to be overcome (besides the private interests with which they come into collision), are very great; still, it is not surprising that in a new country like the United States of America, where the price of labour was very high and ingenuity abundant, in establishing the manufacture of small-arms, they should pursue a different track (and all the more so when

placed under the management of such an able machinist as the celebrated Whitney), in which the successful inventions and mechanical principles of other departments of art are assembled together, and specially adapted to the requirements of the musket or pistol manufacture, at the same time combining them with the true manufacturing principles which have been so eminently successful in other branches of industry.

There having been some difficulty experienced in obtaining the Minié rifle in 1853 and 1854, the government determined to erect a manufactory of small-arms which should combine all modern appliances for saving labour and for securing the most rigid accuracy of production. Accordingly such an establishment has been completed on a scale capable of producing about 1,000 muskets per week. It comprises about 150 horse-power, 3,000 feet of shafting in motion, and upwards of 1,000 machines, or apparatus, for the various purposes of the manufacture. Upwards of 200 of these machines have been brought from America, a few were obtained in Belgium, but by far the greater number, between eight and nine hundred, were made in England, and, in order to insure perfect success, the details are being carried out by an American gentleman, brought over by the government, who possesses a thorough and practical experience in the working of this system in the United States, and who has the assistance of several of his own countrymen, from the small-arms factories of New England.

The leading principle upon which this manufactory has been organised consists of an extreme subdivision of operations, to produce each of the separate parts composing a musket, in order that each operation or process may be in itself so simple, as that it may be performed by an unskilled individual, and at the same time may afford that rigid accuracy of form and dimensions which are essential to perfect fitting, and to ensure that amount of precision which will enable the parts of several muskets to interchange with each other. The operations performed by the several machines are so arranged consecutively, that the greater portion of the work is done, or material removed, by a preliminary class of machines, thus leaving to those that follow after comparatively little to do, merely to produce that degree of exactness which is absolutely essential.

In the Smithing Department, articles such as the bayonet, the several parts of the lock, the ramrod, and even the barrel, are produced by a system of copying either by the forging machine, by dies in the American drop hammer, by rolls containing the form required upon their surface, or by some other modification of that principle, in which the form of the article does not depend on the operator so much as on the apparatus.

When forged, such articles as the bayonet and the parts of the lock, pass to an annealing department, where they are put into ovens to be softened; they then proceed onwards to the pickling branch, where, by means of acid, all the oxide or scale is removed and the pure metallic surface is laid bare; by this means the cutting instruments in the finishing department are preserved from the injury and blunting to which they would otherwise be exposed. In the machine or finishing room (which has an area of 40,000 square feet), where the several parts are cut to the proper dimensions, the tool or instrument which is principally employed in the machines for cutting metal articles is some modification of the circular cutters, technically termed "milling tools." These milling tools are made in every variety and form to produce the required shapes of the several articles, and they are mounted on adjustable spindles, the article to be cut being held in a peculiar vice or holder specially adapted to itself, and by a self-acting motion passing transversely against the revolving cutter, which is so arranged that when the operation is completed the machine stops of itself. When holes have to be drilled in an article, as in the lock plate, for

example, it is enclosed in a perfectly fitting steel box, having a lid provided with holes corresponding with those required; the drilling machine contains a number of spindles, each carrying a drill of the required size, and running at the proper speed. These drills in succession are passed through the respective holes in the lid of the case, at the same time piercing the soft article which it contains; thus perfect identity and absolute accuracy are obtained; and as each machine is used for a single operation only, that operation is thereby rendered extremely simple, and requires but a small amount of care or skill in its performance.

The bayonet, from first to last, undergoes seventy-six operations, each of which is definite and simple, and at the conclusion of the last one, the several bayonets are as much alike as the different pieces of money from the Mint, and they present a degree of accuracy which could not be equalled, even at three times the cost, by the tools or apparatus which have hitherto been employed in England.

To secure such a degree of precision in an article which has to be made by the thousand, involves an entirely different system of manufacture to that pursued by the machinist or the engineer; to select a single illustration out of hundreds that might be named if time permitted—the formation of the hole through the bayonet socket, where it fits upon the end of the musket barrel. The solid iron socket, as it comes from the pickling room, is first put into a milling machine, where, by means of a pair of milling instruments, it is cut at the ends to within the fiftieth of an inch of the proper size; then, by a second machine, it is bored or drilled out roughly, and nearly to the correct dimensions; then, by a third machine, it is bored out still nearer and very carefully by a stationary instrument, with the socket revolving. It then proceeds to another description of machine, to have one end of the socket completed by a revolving tool, then to another similar machine to have the other end completed in the same manner. By a sixth machine the hole is slightly tapered; then, after a number of other operations have been performed on different parts of the bayonet, this hole is again entered by another tapering tool, making the hole within the thousandth part of an inch of the finished dimensions; and lastly, after the bayonet is all but completed, the hole receives the finishing touch. By this system the holes in the socket of each bayonet are perfectly alike, and as the instruments which perform the more delicate parts of the process have so little work to do, they continue for months without the smallest variation. A similar treatment is bestowed on every other part of the exterior of the bayonet socket, on its neck, on the blade and locking ring, also on every other metal part of the musket, but which to describe minutely at the present time would occupy too much space; yet such is the precision of this system on the several parts, that when completed with a small amount of hand finish and polishing, the several parts interchange, and may be selected at random from a heap, to be put together.

The gun stock is an article which, from the irregularity of its form, and the extreme degree of exactness required in those parts where it has to receive the lock, the barrel, and its other components, is obviously a most difficult thing to produce by machinery; this, however, has been done to the utmost degree of perfection. In its manufacture the stock has to pass through some twenty operations, all of which are on the copying principle, leaving only the polishing process to be performed by hand labour, the fitting of the lock, trigger guard, barrel, and all other nice parts being such as could only be equalled by the most careful workmen, no hand finishing being required, while the time occupied in performing the several operations is under half-an-hour, which includes the fixing and unfixing of the gun stock in the several machines.

The same system is pursued in the manufacture of

the gun-barrels, and of all the other parts of the musket, but which, for want of time, cannot be described at present.

The Small-arms Manufactory is now all but completed, and the specimens of its produce, which have been selected at random, are laid on the table for examination. In an economic point of view, this establishment will well repay the outlay which has been incurred in its erection, but it will be found of still greater importance and value as an agent that will afford a higher standard of accuracy and refinement, that will secure that minute degree of precision by which the several parts of muskets may interchange; and if the military gun-makers of England are wise in their generation, they will not despise this system of manufacture, but, on the contrary, will adopt it, for it will secure for them a high vantage ground in competing with other parts of the world. Nor are the peculiar advantages of this system confined to that branch of trade alone, it is capable of extensive application in other manufactures; and the American machinery which has been introduced into England by the War Department is so peculiar, and different from that usually made in this country, that it presents a rich mine of mechanical notions, worthy of being studied by our machine makers. The gun-stock machinery, especially, is a positive addition to the mechanical resources of the nation.

An attentive examination will bear out this statement, and will show that our transatlantic competitors are not behind us in the race of machine-making; that they show an originality and a common-sense in many of their arrangements which are not to be despised, but, on the contrary, are either to be copied or improved upon; and, knowing all the circumstances, I consider that the Government of this country are justly entitled to a large share of credit for the determined perseverance with which they have carried out this great, but unpopular, undertaking, which, I am sure, will be fully appreciated by the nation, when its numerous advantages are properly understood.

AMMUNITION STORES.

During the latter part of the French war considerable life was infused into the construction of laboratory articles, but the method of producing them continued, with little alteration, until within the last few years. After this lapse of time it is difficult to account for indifference to such an important particular, seeing that the numerous inventions of Sir Samuel Bentham and others, which would have been so serviceable, were well known and made available in other departments of the service.

Between the years 1840 and 1853 a few machines were introduced into the manufacture of percussion caps, spherical bullets, and metal fuzes; but, upon the whole, there was comparatively little done to improve the system of production.

In 1853 the Government determined to erect suitable factories or workshops, which should embrace the leading principles of the best conducted manufactories, in which the raw material should enter at one side, and, by a gradual advance, arrive at the storehouse on the opposite side a finished article, and the machinery, as far as possible, should be self-acting. The instructions which were then given have been fully carried out, and to a much greater extent than at that time was anticipated.

Of the more important applications of machinery to manufacture this numerous class of articles, may be enumerated that for producing the ammunition for small arms, shells, fuzes, and war rockets.

The adoption of the Minié rifle having created a demand for the elongated bullet in large numbers, and of extreme accuracy in weight and dimensions, to meet these requirements a plant of apparatus has been provided, capable of producing 500 bullets per minute, or more than a quarter of a million daily. In this manu-

facture the lead is first put into a cylinder, from which it is squirted into a long rod by means of hydraulic pressure; the lead rod is then wound upon iron reels, which are transferred to the machinery for compressing the bullet. The bullet machines are entirely self-acting, and unwind the lead rod from the reels as they require it, first cutting off the required quantity, then compressing it into form, and then delivering the bullet ready for the cartridge.

For each cartridge a conical wooden plug, of peculiar form and exact dimensions, is required. These plugs are made by means of self-acting machinery, for which the wood is first cut up into long square rods by means of circular saws; one end of the rod is put into the iron hands of the machine from the extremity of which the plug is fashioned by a revolving cutter and then cut off by another instrument, and so on until the rod is used up, a boy being sufficient to attend upon several machines: the produce is equal to a quarter of a million daily.

Hitherto small arm cartridges have been made up with several pieces of paper that were rolled into the proper form, to hold the bullet, plug, and powder, an arrangement which has been found liable to some important objections. A few years ago, a method of making seamless sugar bags direct from the pulp, and without the intermediate stage of sheet paper having been invented, an enquiry was made in regard to its applicability for cartridges, and it having appeared after careful examination, to offer several important advantages, more especially with respect to strength with a given quantity of paper, economy, and still more in regard to accuracy of dimensions, that system has, accordingly, been introduced.

In the manufacture of articles, such as cartridges for small-arms, which are required by the hundred thousand, a very trifling additional operation having to be performed during their production, will materially affect the question of economy, and will frequently determine for or against its application; it is, therefore, of essential importance in manufacturing these small seamless bags, that they should undergo no unnecessary handling, or even have to be subjected to the operation of packing previous to the introduction of the bullet and gunpowder, seeing that if they are crushed or even crumpled, the process of opening, in order to receive the bullet and powder, would have to be gone through, thus involving an expenditure of time and trouble nearly equal to the value of the material. Under these circumstances the Government determined to erect a manufactory on purpose; this establishment necessarily contains the ordinary machinery of the paper maker for the reduction of the rags into pulp, and also, in addition, the special apparatus required for this peculiar manufacture, but without the sheet paper-making machinery of the ordinary paper mill.

The special apparatus required for the small arm seamless cartridge bag consists of a number of small perforated moulds, of the same form as the cartridge bag, which are clustered together on the end of a flexible pipe, in which a vacuum is kept up by means of an air pump. Each finger in this group of moulds is covered with a worsted slip cover, or mitten, and the whole cluster is then dipped into a cistern containing the liquid pulp, which in an instant is drawn upon them through the agency of the internal vacuum, combined with the external pressure of the atmosphere. The worsted mittens, with their paper covering, are then placed on driers of the exact dimensions, that are heated by steam, the whole operation of forming and drying occupying about a quarter of an hour.

The same principle of manufacture is also applicable for various other purposes, to some of which it has been already applied, and it will be fully taken advantage of in due time. When the additional apparatus that is now being constructed is completed, it will require daily 500 ammunition barrels to contain the produce. To meet

this requirement, a complete plant of machinery is now being provided for the barrel manufacture.

Machinery has yet to be devised for the insertion of the powder and the bullet, as also to perform the operation of twisting and fastening the mouth of the seamless bag. As these processes are both delicate and hazardous, the contriving of a machine for this purpose is better fitted for the leisure of peace than for the feverish bustle of the last few years.

SHELLS.

Passing to another class of apparatus, that for the production of shells and fuzes, a subject which has occupied a large share of attention.

In 1854, the demand for the ordinary cast iron shells having been extremely urgent, many of the more eligible foundries of the kingdom engaged in their manufacture; still, from numerous difficulties which are almost invariably experienced by a new maker in producing shells of the required exactness, there was considerable delay and much disappointment experienced, both by the Government and the contractors.

Before shells can be made economically and satisfactorily, it is necessary to become acquainted with a number of minute points of detail, the knowledge of which is essential to ensure that rigid precision of form, dimensions, sphericity, concentricity of the core, and perfect soundness of the casting; qualifications which are imperatively demanded. In this extremity it was considered advisable to erect a model foundry, for the purpose of assisting new contractors with the requisite information, and also with the intention of devising a more accurate, and, if possible, a more economical system of manufacture, the method commonly employed having been considered very defective. A new foundry was built accordingly, and furnished with a set of apparatus, which more than realised all that had been anticipated; indeed, so important did the result appear, both in regard to accuracy and the economy of production, that a still larger foundry was determined upon, there being immense stores of old iron, guns, and other castings, available for the purpose of being cast into shells. Such a foundry has been erected capable of delivering 200 tons of shot and shells daily, if such should ever be required. It is provided with 50 horse-power to work the machinery, 8 large cupolas, and every facility for carrying on the shot and shell manufacture economically. The fuel and iron pass in at one side of the establishment; the moulds are conveyed by railway from the moulding area to the vicinity of the cupolas for the reception of the liquid metal, then, without having been removed from the carriage, they are conveyed onwards to the breaking up and cleaning department; the shells are put into the cleaning machine, and the moulding boxes with the core spindles undergo a rigid examination before being returned to the moulding area. The sand also has to be broken up, remixed, and sifted by machinery before it is returned to the moulders. The shells roll on to the bushing machines, after which, by their own gravity, they will roll along a suitable rail across the Arsenal, out into the river by means of a long tube, and into the hold of a vessel for transportation.

The chief peculiarity in this foundry is the moulding apparatus, which is such, that accurate shells are produced with unskilled labour after a few hours' training; its leading feature consists of an arrangement by which the pattern is drawn through the iron plate upon which the mould is formed, thus preserving the fragile edge of the mould from fracture on the withdrawal of the pattern. Each machine has two sets of apparatus, corresponding with the two halves of the mould, but the two halves have no connection until they, along with the core, are assembled on the carriage for the casting process.

The whole of the moulding and core apparatus, together with the boxes, have been made with as much accu-

racy as can be obtained in the present state of the arts, by the processes of turning, planing, and scraping; and it is invariably found, that with correct apparatus the chances of failure are reduced to a minimum. To perform the operations of drilling, screwing, and bushing shells, for the reception of the fuze, a large plant of compound drilling and screwing machines has been provided. In one day of twenty-four hours, during the late war, upwards of 10,400 shells passed through this machinery, a feat which probably could not have been accomplished in any other workshop in the world.

From the completeness of the arrangement, these shells only require to be lifted once, after which they roll onwards till completed; this economical system of rolling has been introduced during the war, and has proved of essential service to the department.

Towards the close of 1854, an urgent demand was made from the Crimea for wrought iron shells, an article of peculiar shape, not unlike an immense champagne bottle, which it was found impossible to get by contract in sufficient time and quantity to meet the demand. In this emergency, a factory capable of producing 100 of these shells daily was erected; it covers 30,000 square feet, contains 4 steam engines, 7 steam hammers, and upwards of 40 machines of various descriptions, many of them original and specially adapted to this manufacture; and this establishment was in operation within two months from the date of order, and that, too, during the severe winter of 1854-5, a fact which is worthy of being recorded.

These shells are made out of a single plate or slab of iron into an article resembling a bottle in form, with six or seven heatings; a remarkable example of what well-organised arrangements will accomplish. Two of the machines that are employed in this manufacture may, from their novelty, be referred to. The shells, having to be of one uniform weight, are turned in a lathe, both inside and externally. The lathe-spindle, however, is a hollow trunk, which holds a shell at both ends, and each shell is acted upon by a dozen or more cutting-tools simultaneously on both sides, and in opposite directions; thus the whole apparatus is thrown into a condition of equilibrium, and relieved of the inordinate amount of friction which would otherwise exist, and the time required is reduced in proportion. The other machine that has been referred to is for converting the red-hot cylindrical mass into the form of a bottle, which it does in less than five minutes. To have performed this operation by the ordinary means of the smithery would have involved many extra heatings of the article, would have greatly injured the material, and, at the same time, would have been very expensive. By this contrivance, the red-hot mass is put into the giant grasp of a most powerful apparatus, and is acted upon in all directions by an intense percussive force, thus leaving the article no other alternative but to change into the required shape, and without any crumpling of the edges, as might be expected.

Another branch of the shell department is the manufacture of the wooden sabots, which has been well developed. In this plant of machinery, the whole of the cutting-instruments are mounted on a combination of slide-rests, which are all actuated by one movement in their several directions, until brought into contact with a fixed stop. The adjusting of this stop determines the several dimensions of the article, while the shape is dependent on the position of the tool-holders. These things were formerly made by the ordinary tools of the wood-turner, in the usual manner; but, with this apparatus, boys or unskilled men are quite sufficient, and the relative rates of production are increased from 7 to 50.

The hemispherical interior of the sabot, where it has to fit the shell, is cut out in an equally ready manner. The gouge, or cutting tool, is fixed on a moveable centre, with the cutting edge set at the proper radius, then, by giving a forward movement with the left hand, and a

sweep to the tool holder with the right hand, the true surface is produced in a few seconds, the exact depth being determined by an adjusted stop.

A very perfect and extensive plant of machinery has been provided for the manufacture of the different sorts of shell fuzes, both wood and metal, capable of producing 8,000 daily, which, for accuracy and economy, it will be found difficult to excel, and in regard to production, it is fully equal to the wants of any emergency, but to enter into detail would require more space than is at present disposable.

WAR ROCKETS.

The manufacture of war rockets is a subject which has occupied a large share of attention, and the greater portion of a plant of machinery has been erected, which will, when completed, produce 500 daily. The wrought iron tubes will be made by the lap-welding process, then cut to the proper lengths, bored, turned, and drilled by specially adapted self-acting machinery. Hitherto war rockets have been filled with the composition by hand, and driven by means of a falling weight worked by a number of men. This system is now being abandoned, and hydraulic pressure substituted. As this is a dangerous operation, the new works are removed from the vicinity of the other manufactories to a piece of ground consisting of about 114 acres, which has been enclosed from the marshes, and now forms a part of the Royal Arsenal. On this piece of ground a steam-engine, with the requisite hydraulic machinery, has been erected. The water pressure is conveyed through pipes to the several press houses, which are separated from each other by strong traverses, which, in the event of accident, may prevent communication; indeed, everything which may be considered as conducive to safety, has been done regardless of expense.

Machinery on an extensive scale has been applied to the manufacture of percussion caps, friction tubes, and to every description of this class of war stores, and also to an extensive range of articles, which are made of sheet copper or tin plate; most of these machines have been brought from America, and are well worthy of extensive application in the general tin ware manufactures of the country.

GUNS AND GUN CARRIAGES.

Passing to another class of articles—to the manufacture of guns and gun carriages, it will be found, to say the least, that the tools and machinery in the establishments of the War Department are not behind any private manufacturers, either in regard to efficiency or an economic system of production.

About the year 1780, boring mills, to be worked by horses, came to England from the Hague; these were in use till 1842, and although clumsy, were provided with veritable slide rests, and in their day must have been considered fine specimens of engineering. Between 1842 and 1851 a complete plant of machinery was introduced for the manufacture of brass ordnance, which, although on a limited scale, was fully equal to anything which has since been accomplished, and is all the more interesting from the circumstance that here the course of improvement may be said to have commenced. In 1855 the demand for brass guns was so great that a considerable extension had to be made to the plant, in order to raise the production to twelve guns per week; and many improvements have been introduced, more especially in the casting department. Brass guns had hitherto been moulded on a loam model, requiring renewal for each casting, a system which is still employed in most of the continental foundries; this, however, has been abandoned, and a system of metal patterns with sand moulds in iron boxes has been substituted, by means of which more accurate castings are obtained, and at a less cost. Extensive additions have also been made in the erection of additional machinery for the boring and finishing

branches, and also for producing the several mountings required both for brass and iron ordnance for the army and navy, in any quantity likely to be required during a period of war.

From the great failure of the iron mortars at Sweaborg, and the great difficulty experienced in obtaining iron of the proper quality and strength of metal, without previous preparation on the part of contractors, the Government determined to erect a foundry and boring mill capable of producing five heavy iron guns daily. In this establishment the great aim will be to secure metal of the strongest quality. An extensive course of preparatory experiments is now going on with Indian, Swedish and Nova Scotia irons, as also with the best of the British brands and their several mixtures; these tests are both chemical and physical, and from them important and useful results are likely to be derived.

In this manufactory of iron guns, every detail conducive to economy has also been attended to. In the foundry there are 10 wrought iron casting pits from 15 to 20 feet in depth, 20 boring machines suitable for the heaviest description of ordnance, with the other machinery and lifting cranes of a corresponding character; altogether this will be one of the finest establishments in the War Department, and fully commensurate with the present requirements of the service.

The manufacture of gun carriages had been in advance of the other departments in the employment of labour-saving machinery for working wood. During the latter part of the French war, the inventions of Brunel, Maudslay, and Bramah, were made available to a limited extent, consisting chiefly of sawing, planing, and other machines, but still the greater part of the work was done by hand labour.

Within the last few years all the improvements of modern machinery have been applied; upwards of 300 labour-saving machines have been brought into operation, besides some twenty steam-engines. In such an extensive collection, while many of the machines are common, there are a number which have been brought from America and France, that contain many novelties worthy of the attention of private manufacturers; but which, in a short paper, cannot even be named. Of the more important works may be enumerated a new saw mill, with 80 horsepower, containing all the latest improvements in sawing machinery; the saw frames are large enough to admit a log of timber 5 feet square; the mill contains a circular saw 66 inches in diameter, which is arranged to square the ends of the logs in the several frames, and to cut in a transverse line from one side of the mill to the other, the saw being moveable, and the timber stationary; it is also provided with apparatus worked by the power, for drawing the heavy baulks of timber and delivering them on the trucks between the saw frames. Adjoining the saw mills a large timber field has been laid out, which is provided with a system of railways, on which are a number of overhead travelling cranes, arranged to traverse the whole field, and to pile up the baulks of timber in the best position for seasoning.

Until recently the wheels of gun and other carriages were made entirely by hand labour; they are now wholly made by a system of copying machinery, which has been very successful, and is worth examining by private manufacturers who may still make their carriage wheels by hand. The wheel making is carried on in a room 100 feet square, covered with the saw-roof arrangement, which admits only of a northern light; it is provided with parallel lines of shafting at every twenty feet. Among the more interesting machines may be named the endless ribbon saw, which is extensively used in the War Department for many purposes; here it is used for cutting out segments and every description of intricate sawing, which it does in a style as regards both speed and quality, superior to any other. Endless ribbon knives, on the same principle, are being employed in cutting out the cloth in the flannel bag cartridge manu-

facture. The wheel fellows are turned in a lathe in which the *form* of the *corner* is made in the cutting tool; this tool being held in a slide rest is pushed against the revolving fellow, which is completed in a few minutes. The nave is turned in a lathe, in which the cutting tool is guided in the required irregular line, irrespective of the workman, a copy or profile of the nave being attached to the slide rest. The morticing of the fellows and naves for the reception of the spokes, is also done by machinery. The spokes are cut to the proper shape by self-acting copying lathes, in which an iron pattern of the required shape is placed, and is accurately traced by the apparatus, which is so simple, that a labourer can attend upon three machines. When the several parts of the wheels are completed, they are laid in position within a circle of six hydraulic presses, all pushing towards a common centre, by which they are quickly, securely, and firmly put together. This manufactory also contains an American dove-tailing machine, the first of the kind in England, which only requires to be known to the cabinet trade to insure its general introduction; another machine, termed the American Eagle moulding machine, has also been ordered by the War Department, but it has not yet arrived; this will also form a useful auxiliary to the cabinet making trade of this country, more especially in the manufacture of chairs: it is also used for many other descriptions of irregular copying in the United States.

A peculiar feature in the application of machinery in the War Department is, the frequent and successful attempt to congregate a number of instruments together, in such a manner that they may act on an article, or series of articles, simultaneously. To select two examples—one machine is mounted with twenty or more circular saws, on different spindles, horizontal, vertical, and at various angles, so arranged that a passage through the whirling group will produce the required shape or form; a number of pieces of timber are fixed to a moving table, and one after another pass through the saws, and are instantly transformed into shape. Again, there are machines in which some twenty or more drills are arranged in the same manner, and placed so as to drill upwards, in order to get rid of the chips; this principle of operation is extensively used for hard-wood morticing purposes, in various ways, and is very expeditious.

Ordinarily, the sand and glass preparing of wood-work, even in large manufactories, is performed by the hand; in the War Department, the glass is mounted on drums, about four feet in diameter, which are driven at a high speed; by this arrangement the work is performed more rapidly, and yet with sufficient nicety for the class of articles to which it is applied.

An extensive manufacture of wooden boxes and packing-cases is carried on, in which the whole of the preparatory work of sawing, planing, morticing, drilling, and dowelling, is performed by special machinery, leaving only the putting together to be done by hand. During the war, there were upwards of a thousand of these boxes made daily, which involved considerable expenditure of labour in the mere conveyance of the material to and from the machinery, and onwards to the central depot, where the parts are assembled. A saving of labour has been effected by an arrangement of endless horizontal bands. The principal band extends along the side of the building that contains the machinery, and is in constant motion towards the depot; within the building and from each machine is placed a series of similar, but shorter, bands, all working at right angles to the former. As each piece of wood is completed at any machine, it is thrown upon the transverse band by the workman, and by it is delivered upon the long band which conveys it to the depot, where the parts are separated into bins, ready for the workmen who put the pieces together into boxes.

The quantity of this class of articles that is required is enormous. Last year, they numbered 287,171. Of heavy mortar-beds, gun-carriages of different descriptions,

with the limbers for the travelling-carriages, and traversing platforms, the large number of 3,715 were produced, and the total number of complete articles which passed through the department amounted to 445,231. Their component parts, if reckoned, would number many millions.

A considerable amount of forged wrought iron work is employed in the construction of gun carriages, and from the circumstance that many of the articles are required of the same shape, an opportunity has been afforded of producing many of them by means of steam hammers and other machines, which, were a fewer number required, would have to be made by the hammer and hand of the blacksmith. An extensive variety of such articles is made in dies under the steam hammer; the piece of iron is first roughly bent into the shape, then made welding hot and put between the dies; a single blow squashes it into every crevice, and the fin which is left in the middle where the dies join, is afterwards cut off by being pushed through another die by means of a punching machine.

A rolling mill and scrap forge, in connection with the smitheries, has been found exceedingly useful in affording the means of obtaining peculiar forms of iron bar that are not to be had in the market, and also to work up the whole of the scrap iron of the departments. An interesting feature in this rolling mill is a method of making large flat rings, or segments of bar iron, four or five inches in breadth, and from four to eight feet in diameter; to roll such a bar into the form of a hoop is common, but the making of rings is not so general; it is accomplished by placing a rigid guide behind the last groove in the rolls, so that, as the red hot bar issues therefrom, it comes into contact with the guide, and thereby is constrained to sweep round into the curve required, which it does in an instant of time, and without any additional expense having to be incurred. An immense number of similar and equally important contrivances could be named if the time permitted, for although these minute details constitute the keystone on which the success of a manufactory mainly depends, still, from their number, they are not admissible into a general statement.

GUNPOWDER.

Of all the stores required by the war department, that of gunpowder is perhaps the most important. It is pre-eminently essential, not only that it should be the very best that can be made, but, what is even of still more importance, that it should be of uniform quality and strength, in order that the artillerist may direct his projectiles with precision and effect. The quality of gunpowder being dependent both on the careful selection of the ingredients and also on the care bestowed on the several processes of manufacture, the advantage of having an establishment to raise the standard to the highest point of attainment, is sufficiently obvious; it is also useful in controlling the price of gunpowder during the time of war. During the French war there were three government manufactories of gunpowder; there now remains but the one at Waltham Abbey. From the large stock of powder on hand at the peace in 1815, this establishment, by the year 1840, had sunk to a very low state. At that time the produce was only equal to about 3,500 barrels per annum, and the greater portion of the plant and machinery was completely worn out. In that year commenced a course of improvement which has been continuous up to the present time, the produce now being about 17,000 barrels, and, in a short time, it will amount to 20,000 barrels per annum.

One of the leading features in the many improvements is the substitution of metal for wood in the construction of the powder machinery. The wooden water-wheels, erected by the celebrated Smeaton, are being replaced by light iron wheels, with every modern appliance to make the most of the water-power.

The driving gear of the incorporating mills has been

placed underground, so that in the event of explosion it may be safe from the destructive effect; and water-tanks have been placed overhead, ready at any moment, to deluge the mill in the event of explosion in the adjoining house, the communicating arrangements being self-acting.

A new system of granulating machinery has been introduced to take the place of the far more dangerous process of hand-corning. As this is by far the most critical part of the manufacture, a large amount of care has been expended to make the operations as safe as may be attainable. The machine has been made self-acting to an extent which dispenses with any attendance. A quantity of pressed cake is put into a hopper before the machine goes to work; from this magazine it supplies itself by means of an endless band, and then, by toothed rollers, it breaks the hard cake into the different sorts of grain, then, by an arrangement of sieves, it separates them and deposits the various qualities of coarse and fine grain in their respective boxes; as these boxes become filled, the machine removes them of its own accord, and puts down empty ones instead, until its supply is exhausted, when it stops of itself, and after having done so, and all danger being over, it then rings a bell for its attendant, who, meanwhile may have been reading a book in a place of safety provided on purpose.

This manufactory contains twenty-one water wheels, each on an average of four horse-power, and one steam-engine of 30 horse-power, and upon the whole is a very creditable establishment, while in regard to quality the powder is considered second to none in the world.

FLOATING FACTORY.

The numerous wants of the army in the Crimea, and its great dependence on mechanical resources, suggested the idea of sending out a floating factory. A screw steam vessel, of 600 tons, having been procured, she was fitted up as a factory, with gearing and all the usual tools of an engineer's establishment; it contained a cupola, four smith's forges, twenty-eight heavy machines, and many thousand small tools, and a general assortment of such stores and materials as were likely to be required; it also contained a complete saw mill, with all the requirements of a brass and iron foundry, an arrangement of portable engine, standards, and shafting to set up a manufactory on any level piece of ground ashore, if such should be required. The engines of the vessel were arranged to work either the screw of the ship or the machinery; and in ten weeks after the War Minister gave the order this vessel was ready for sea, with a manager and as fine a body of picked workmen as could be desired; they were all selected in the vicinity of Newcastle-upon-Tyne. On arriving at Balaklava the immense importance of the establishment was at once demonstrated; a foundry was set up on the shore, which was kept in constant employment while the vessel remained in the Crimea. Requisitions poured in from all branches of the service, which were executed with an alacrity that excited the commendation of all concerned. Seventy-nine requisitions were made for repairs to the railway plant, forty-nine from the navy, and sixty-eight from the steam transport corps, independently of the legitimate work of the factory for the Commissariat and Land Transport Corps.

The floating factory was visited by the chief officers of the French, Sardinian, and Russian services, all of whom expressed their surprise and admiration, declaring that it, together with the railway, gave them a higher opinion of England, her resources, and her settled determination to conquer ultimately, than almost any other transaction connected with the war.

Besides the floating factory, several other plants of machinery were sent out; among the rest a complete saw mill, with suitable steam engine to Sinope, another to Balaklava, with both circular and frame saws, and other machinery.

PIER AND HYDRAULIC CRANES, &c.

Of the miscellaneous services carried out during the war, one of the most important was the erection of a pier at the wharf of the Royal Arsenal, extending out into deep water, by means of which four of the largest class of vessels can lie alongside during all conditions of the tide: and in connection with this pier is the application of hydraulic power to work the cranes.

Hitherto ships had to lie off in the river, and to be loaded or unloaded by means of barges, which were floated alongside, and to or from the wharf.

By the new arrangement four ships can draw up to the pier at one time, and by means of the hydraulic cranes, the work of a week is reduced to ten hours, the limit to speed being the time required to stow away or sling the articles within the hold of the vessel.

During the six months ending the 30th November, 113 transports, representing a tonnage of 69,975 tons, were unloaded, which is exclusive of the ships that brought home the Land Transport Corps, the troops, horses, and their several equipments. The whole expense of this service, including the steam engine and hydraulic accumulator apparatus, and the cranes, amounting to nearly £33,500, was cleared off in the saving of the time of vessels alone during the first six weeks that it was in operation—an important consideration, although secondary to the far higher advantage which it affords the War Department, in the rapidity with which it can embark war material and stores.

Until last year all ordnance stores were conveyed to the outposts in sailing sloops; but small screw steamers are now being introduced, the advantage to be derived therefrom being so obvious as to require no explanation.

The Armstrong hydraulic apparatus, for working the cranes, is also being adapted as an immense fire extinguishing engine, with an air vessel to produce the continuous squirt of water. This air vessel is in the form of a cylindrical steam boiler, with hemispherical ends, and is placed vertically. In connection therewith an iron reservoir, 100 feet in diameter, has been placed on a hill in the vicinity, 220 feet above the Arsenal, and is filled through the fire mains by the hydraulic apparatus. In case of fire, the water in the reservoir is always ready, meanwhile the steam engines, equal to 30 horse-power, will go to work on the pumping apparatus as an auxiliary, and the two combined will afford a plentiful supply of water, equal to the requirements of any probable emergency.

There are 69 steam-boilers in the War Department,—it is, therefore, of importance that everything conducive to safety and economy in fuel should be carefully attended to. In order to secure these two conditions, a system of reporting has been organised, for the purpose of showing the working history of each boiler, in regard to proof, times of examination, cleaning, and repairs, also the consumption of fuel, the quantity of water evaporated by a pound of coal, and other particulars. The greater number of the boilers are supplied with Kennedy's water meter, by means of which, precise and definite knowledge of the comparative merits of the several boilers, and the evaporating value of different coals, will be obtained.

This general statement may afford some idea of the magnitude of the various operations of the war department, though at the same time it conveys but an imperfect notion of the amount of mechanical detail which has been grappled with; such details, however, are equally important, and frequently involve greater perplexity, mechanical ingenuity, and resource than works of larger magnitude, but lying in the background they can only be known or appreciated by those who have been engaged in similar undertakings.

This subject has been brought before the Society of Arts as an humble contribution towards the practical application of science, in connection with the arts, manufactures, and commerce of the country, and I trust also it may serve to show that the appliances of the national

establishments are not necessarily so deficient and so far behind as they are frequently represented to be; but that, on the contrary, they are fully equipped with the latest improvements of the age, and need not fear comparison with any private undertaking in the kingdom.

DISCUSSION.

The SECRETARY stated that he had received the following communication from Mr. W. Bridges Adams:—

The machinery at Woolwich Arsenal for the manufacture of wheels for gun and other carriages, is fast approaching perfection, but the wheels themselves are still the rude primitive constructions, as regards principle, that Thespis might have used in his original cart. A lump or hub of timber is cut from the butt of a tree. A series of levers are fixed round it, capstan-bar fashion, but without the proportioned strength of the capstan bars, each of which is equally strong all over, whereas each spoke is so reduced at the tenon, or holding part, where it enters the hub, that it would break short off if unsupported. The extreme ends of the levers are framed into the fellies, or string segments, two and two, in such wise that the spokes must be made weak in the direction of the plane of the wheel, in order to draw them together, to enable the extremities to enter the mortices. The fellies, where they abut against each other, are dowelled into short cross grain, produced by the curved form, and constantly break off at what are technically called the "chins," and loose segments of iron bar, technically called "strakes," are spiked on to the felly "break joint."

Such wheels as these are now only to be found in remote districts, and the only apparent reason why they are continued in government artillery, is some fancied facility of repairs when damaged in use in the field.

These wheels are so applied to the axle-trees, that the lower spoke presses vertically on the ground, in order to prevent side rack and strain. But the result of this is a total absence of elastic resilience. As the wheel revolves with its load, blows from the irregular surface of the ground, act like tilt hammers, and drive the spokes partly into the hub, and partly into the fellies, but most into the hub because it is the softest wood, rendering the whole loose. But there is a worse evil than this. No hub is equally hard all round—the weather side of the tree is the toughest—consequently the spokes drive unequally, the wheel becomes eccentric, and the irregular action is like that of a sledge hammer, rapidly destroying it.

When this class of wheel is improved, as in the ordinary omnibus, by shrinking on a hoop tyre, there is another difficulty. The spokes are thinnest in the direction of the plane of the wheel, and if the shrinking be too severe, they lose their straightness, and tend to lap round the hub, weakening the structure. As the hubs are not of equal hardness, scarcely any two wheels are alike in dish or diameter. If the spokes do not yield in the direction of the plane of the wheel, but are forced over in the direction of the axle or "dish," the tendency is to draw them forward, and leave gaps in the hub behind. When the diameter of the wheel is thus lessened, the tyre gets loose, and is then "cut and shut," to reduce it in diameter, and the gaps at the backs of the spokes are increased.

Criticism is of little use, unless the critic has a remedy to offer. My remedy is first to dispense with the hub altogether, and mitre the spokes together at the centre in an arch form, bolting them between strong wrought iron disc plates front and back. The section of the spokes is such as to leave twice the strength in the direction of the plane of the wheel, to that in the direction of the axle. Each spoke has a single felly, the joints being between; the fellies being short there is no cross grain to break off the "chins." No dowels are applied, but instead of these a thin piece of narrow hoop

iron is inserted in a saw kerf, half in each felly, which keeps them in plane, while the tyre is shrunk on. No shrinking of the tyre can damage the wheel, for the elastic resilience is in the direction from back to front, tending to produce a ribbed dome-shape, the true form of a wheel.

I had come to the conclusion from theory that every spoke ought to have its separate felly, just as every leg has its separate foot, independently of the obvious disadvantage of straining the spokes to get them into the double felly. But I also obtained practical evidence of it.

Watching on one occasion the pulling to pieces of a pair of large Hansom cab wheels, the fellies of which were made of hard wood, I found almost every double felly had separated into two parts, equi-distant between the spokes, forming, in fact, single fellies, and the separations were as clear and peculiar as the sutures in a skull bone, scarcely showing on the external paint. The reason was obvious. The wheels being of larger diameter, and revolving rapidly, the alternate blows at the ends and centres of the fellies concentrated the vibrations at the centre, precisely in the mode in which axle-trees break after long service. Each spoke served as a fulcrum to produce this effect. It was therefore clear that the structure which the wheel tended to generate in action, was the true structure to begin with, unless the fellies could be made in an entire solid piece.

I tried this experiment also, constructing the wheel centres of mitred spokes, disc plated, and the fellies of a hoop of angle iron, into which the spokes abutted, and were very carelessly secured by staples round them, riveted into the angle iron. The wheels so made were placed under a cart, to carry heavy loads of iron. After being a considerable time in use, one day the angle circle escaped from one of the wheels. The driver lifted it into his cart with the rest of the load, and drove home on the spoke ends, which, when he arrived, bore the appearance of overworn crutches. The remark of one of the initiated in wheels on beholding this was, "No wheel that ever I saw before could do that."*

It is obvious that a true circular form can be preserved by this kind of centre, but there is another advantage. The wheel, being dome-form, will be elastic, and if the axle be horizontal, the spokes will never be vertical to the ground. Consequently the result will be a spring action, diminishing draught and injury to the horses, while ensuring far greater durability. It will be as though a man alights on his toes instead of his heels in jumping from a height.

I frequently conversed with the late Colonel Colquhoun, of the Woolwich Arsenal, on this subject, and he agreed with me in the principles, but the application involved such a radical change, and a new teaching in all departments connected with the working and repair of wheels, that he considered it preferable to go on in "the old way."

It is, however, a most important matter, and the facility of repairs in the field would appear to be quite as great as with the primitive wheel. By means of an efficient screw tool, this wheel could be compressed into the cold hoop tyre in the open field very rapidly, and the parts being all duplicates, no error could occur. I think common labourers would be adequate to the work after a few weeks' practice.

Wrought iron cannon to place on wheels, so as to get greater strength, appear to be conceded as a desirable thing, provided only they can be easily and cheaply made. This is a question of welding. Usually the process of welding is performed by heating the separate masses of iron and forcing them into union by violent percussion.

But what are called "cold shuts" occur in this process. Heated iron attracts oxygen from the atmosphere,

and scale is formed, which separates the iron just as flour separates bakers' loaves, and prevents adhesion. If two surfaces of clean iron be placed in contact, and heated to welding point, they will unite with little pressure, and without percussion.

But it is difficult to accomplish this with thick masses, and it is worth inquiring how otherwise it may be accomplished.

The common example of a tallow candle shows us that the contact of atmospheric air is necessary to produce combustion. As long as the wick is surrounded by the hollow wall of flame, it will not consume, but protruded beyond the wall, and in contact with the atmosphere, it begins to disappear.

The use of the common forge has probably obscured the true principle of manipulation. The blow-pipe heat is the thing we require, and the forge is a very inconvenient blow-pipe. Carburetted hydrogen produces the heat we require. If the carburetted hydrogen be put under considerable pressure, it may be made to issue in jets so as to cover any surface or amount of surface we may require. If atmospheric air or oxygen be put under pressure, it may be made to impinge on the surface in contact with the carburetted hydrogen, and the flame and heat will exist at these junctions. In this mode a solid sheet of flame of great intensity may cover the surface, and no scale or oxyd can form with the flame so covering it. This flame being made to cover two opposite surfaces it is desirable to unite, when the pasty condition called welding heat is attained, union may be produced by hydraulic or other pressure without percussion or crystallisation of the metal, and a homogeneous mass will be the result. If, therefore, plate-iron be rolled up in short lengths of many folds, these short hollow cylinders may be united and a perfect cannon produced.

The desirability of cheapness and accuracy in gun stocks, has led to the invention of exceedingly complicated and accurate machinery, like the manufacture of pins. Regarding the gun as a projectile weapon, the conditions desirable are lightness for convenience of carriage, and form to give facility in taking aim. A man's eye is situated several inches above his shoulder, and to get the range of the barrel with convenient hold to the shoulder a considerable curvature is required. But when used as a spear or pike, by the addition of the bayonet, this curvature is a disadvantage, and the more so as the curvature involves short cross grain and risk of breakage. The result is a trial of compromise, and the more convenient the weapon is as a pike the less convenient it is as a projector.

It is, therefore, worth raising the inquiry whether it be not a practicable thing to substitute steel for walnut trees in the construction of stocks. The disadvantages of wood are numerous—shrinkage, brittleness, swelling, and others; and these considerations, no doubt, gave rise to the construction of the famous Doune pistols, formerly used by the Highlanders.

No doubt this change would need a new arrangement of barrel as well as stock, but if, as is probable, a weapon no heavier to carry, equally available as a projector, and superior as a pike can be produced, with a material more desirable and procurable at pleasure, the sacrifice of machinery however perfect, for other machinery producing the improved gun, would be a very profitable loss.

Mr. ASTON said they must all feel indebted to Mr. Anderson for his paper. The subject was one of the greatest interest and importance to the country. Some disappointment would, however, be felt by some, that more information had not been given on certain points. It was pretty well known that very large orders for machines had been given in America and this country, and that they were being fitted up in the Government establishment by the thousand, and that was, in fact, all that they had been told. But many, doubtless, hoped to have learned that evening what

* The disc centre alluded to was not originally an invention of mine. It was first used by Mr. Walter Hancock in his steam carriage, but not as a disked wheel—only as a cylindrical wheel. If I mistake not there is a model of a disc mitred centre wheel in Woolwich Arsenal.

measures had been taken to ensure that so vast and expensive a scheme of manufacture was based on the right principles—to have been told more specifically what successful results had been, and were now being obtained—in short to have obtained more exact information, to satisfy the public that the right thing was being made in the right way. A great deal had been said of the number of machines employed in the manufacture of small arms, and much detail had been given about some minor part of the musket, but respecting the barrel, which of course was the really effective part, no information had been afforded. Surely it would have been most interesting to have known that these barrels, which are to be made at the rate of 1,000 per day, would be constructed on the best known principles, if this were really the case. Again, great stress had properly been laid on accuracy of workmanship, and they had been told that the manufacturers of this country might learn most valuable lessons from the novel construction of the machines imported into the Government establishments, by means of which the various parts of a musket were being made in vast quantities, all alike to the 1000th of an inch. They were led to infer that a system of workmanship on this scale of accuracy excelled what had been hitherto done in this country, in the reproduction of parts of machines; but, without detracting from the merit and value of American workmanship, they might remember that in the machine manufacture of this country a greater degree of accuracy than that alluded to was not uncommon. In the Lancashire workshops, parts of machinery of complicated form (the spinning machinery, for instance) had long been made in vast quantities, being all *fac-simile* copies of a primary pattern; and it was well known that there were establishments in that district where workmen in the ordinary course of their business, work to the 10,000th of an inch, and where measurements can be made the millionth of an inch. It would have been interesting to have heard from Mr. Anderson what system of measurement was employed to obtain the accuracy he speaks of, and what means are adopted to insure that the copies now and hereafter produced shall always be *fac-similes* of a primary pattern. With respect to the advantages to be gained by the public, it would certainly be satisfactory to be told that the government had now an establishment where the best arms and ammunitions of warfare are manufactured in the best manner; where the public are invited to come, examine, and learn, and in which government is prepared to teach, and work with the private manufacturer. But it was doubtful if it would be thought equally satisfactory to be told that government establishments were all at once set on foot, filled with most expensive machinery, backed up with all the resources of a public purse, in which government was prepared not to invite, but to defy, the competition of private manufacturers. It seemed to him that the public would be justified in requiring more information than had been given this evening, both as to practical beneficial results, and as to correct principles in the construction of the things made, and the manner of making them, and that, until such information be given, it could not be called upon to assent to the proposition, that the undertaking all at once set on foot on so extended a scale, was one based on prudent and sound principles.

Mr. HYDE CLARKE said he thought it was important that they should not misapprehend the aim of this paper. It did not occur to him, when Mr. Anderson made those remarks with regard to the American inventions which had been introduced into the Government establishments, that it was intended in any degree to represent that English manufacturers were behind our transatlantic brethren in ingenuity; but it seemed very natural, on the ground stated by Mr. Anderson, that the Government, in adopting new machinery for the purposes of the manufacture of small arms, should resort to that country and to those establishments which already

afforded the best models. From peculiar circumstances—not only those mentioned by Mr. Anderson, of the dearthness of labour in the United States, but likewise from the facilities which formerly existed for obtaining capital for the purpose of establishing large plants of machinery, under a limited liability, there was a facility in the United States for the introduction of various descriptions of labour-saving machinery. They, therefore, found there not only the best models for small-arms machinery, but there, also, shoemaking machinery was carried out upon the largest scale, and the sewing machine was successfully established. Therefore, he thought the Government, instead of being liable to obloquy for availing themselves of the models which they found in America, must be entitled to praise. Artificial circumstances there had given rise to the production of labour-saving machinery; but, with the recent changes in joint-stock enterprises in this country, which had taken place, it was probable that this difference would no longer exist, but that our manufacturers and inventors would have those advantages in the establishment of machinery which they had not yet enjoyed.

Mr. JAMES PLATT (of Oldham), as connected with the machinery establishments of Lancashire, to which allusion had been made, would state that he had been frequently in the habit of visiting our public establishments at Woolwich, and if, some five years ago, he had been asked the question whether he thought it good policy to construct the extensive works which now exist there, he should have hesitated in giving an opinion in favour of it, but judging by the results produced, he had come to quite a different conclusion. He had been in the habit of visiting most of the leading establishments in England and Scotland, including those of Newcastle, and he would do the arsenal at Woolwich this justice, that no other single establishment, nor any half-dozen in the country, could be compared with it. There had been an amount of ability and perseverance displayed there which he thought was entitled to the thanks of the country, and he would only say, speaking from association with other engineers and machinists, that the feeling in Lancashire was almost universal, that what had been done at Woolwich had been done with the greatest judgment, and the result would be not only that there would be great economy in the work produced, but in future they would never hear again of tools failing when brought to the test of actual use, as was alleged to have been the case in the late war. He was sure that Mr. Anderson, in his paper, had gone into matters very extensively, indeed, as much so as the time allowed. He merely rose, as a practical machinist, to bear his testimony in favour of what had been done at Woolwich.

Mr. HOBBS thought quite sufficient had been said in the paper to induce the manufacturers of this and other countries to test the principle; and he believed they would find that wherever there was a series of articles required to be produced in sufficient number at one time, the application of machinery would be found to be the best mode of meeting the case. If they wanted a dozen letters copied, perhaps the pen would do it best; but when a large number of copies was required, they must have recourse to the printing press. The same remarks applied to all kinds of manufactures. One thing in particular had been mentioned, which he thought very highly of—that was the loading and unloading of ships by means of hydraulic cranes. He thought the time was past when a person going into the London Docks, should see fifty or sixty treadmills in operation, for the purpose of loading and unloading vessels. They might, in this respect, with great advantage follow the example set at Woolwich. The details of the various manufactures, as Mr. Anderson had stated, were, no doubt, difficult to describe. He thought when Mr. Anderson found he had the plant and tools all complete, the shafting up, and the belts and machinery running,

he had then only just begun. It was often the case with those who adopted machinery. They produced the wrong thing at first, but after working wrongly for a short time, they in the end arrived at the right method. When these immense establishments were first set up at Woolwich, he stated to the gunmakers of Birmingham, that they would have the laugh in the first instance, but that gradually the laugh would go to the other side of their mouths. Unless the gunmakers of Birmingham adopted some different system in manufacturing guns, they would be compelled to give up the trade. No man could walk through the streets of Birmingham without meeting large numbers of boys, carrying in their arms parts of guns; and at the lowest calculation he should say 5 per cent. of the cost of manufacture was paid in the shape of wages to those boys. He hoped that what Mr. Anderson had said with regard to the introduction of machinery would not make the country machine-mad; for a man might expend a great deal of money and labour upon a machine, and after all find he was wrong. He (Mr. Hobbs) would suggest, as a step preliminary to the introduction of machinery in any particular branch of manufacture, that they should endeavour to reform the minds of the workmen before they began. They had more to contend with in the workmen than in the want of capital. In America they might set to work to invent a machine, and all the workmen in the establishment would, if possible, lend a helping hand. If they saw any error they would mention it, and in every possible way they would assist in carrying out the idea. But in England it was quite the reverse. If the workmen could do anything to make a machine go wrong they would do it, and if the same amount of ingenuity on the part of the English workmen were exercised in producing labour-saving machinery as he (Mr. Hobbs) had seen displayed in producing the least amount of work in the longest possible time, England never need fear that other nations would go ahead of her in this respect. He thought the great obstacle in the way of the gunmakers of Birmingham in introducing machinery, was the opposition of the work-people to such innovations. They thought if they could by any possible means raise the cost of production, no matter by what means, they were doing good service. If any machinery was adopted for reducing the cost of manufacture—not the wages of the workman, the men nevertheless set their faces against it. Unless they could get the workmen to go heartily with them from the first, he (Mr. Hobbs) would advise them to be careful how they attempted to introduce machinery.

After a few remarks from Dr. WAMPEN,

Mr. WM. SMITH said, he thought it would be useful to be informed by Mr. Anderson, whether he had found any advantage in dividing the work to be performed into a number of separate processes, to be accomplished by a number of different machines, instead of performing the greatest number of operations in the same machine. He had observed in visiting the works at Woolwich, that a great variety of articles heretofore produced by hand, was by simple machinery now produced with great rapidity and uniformity. There was, in particular, one article on the table which he believed had not been alluded to in the paper, viz., a sword scabbard. It was a very simple-looking article. The quantity of material removed as compared with what remained in the finished article was great, and the form such that he imagined the operation was somewhat difficult of accomplishment by machinery.

Mr. ANDERSON replied, that if the article was heavy and difficult to handle, and required but little to be done to it, then perhaps one machine was best; but where, as in the case of the wooden lining of the scabbard, the operations had to be repeated, and many thousands of the article produced, it was very different. In making fuses or other small things, it was found the most economical to hand them from one boy to another through the several stages until they were completed, and by so doing a smaller

amount of wages was paid in the aggregate than if a single person produced the same article. With regard to the scabbard lining on the table, it was just as it left the tool. It was done entirely by the sawing process. It was first cut out by the endless ribbon saw, and the groove was formed by a circular revolving cutter. It was the same with regard to the outside of the article; the tool being set to the proper curve produced the form.

Mr. NEWTON remarked with regard to Mr. Anderson's paper, they must be all agreed that it was a highly interesting one, and that he had put as much matter into it as he could for one evening. It was very well for gentlemen to wish to have detailed explanation of machinery, but when they considered the enormous number of machines that were required for the various operations, they would see that if the details, even of a few of them, had been given, the other portions of the paper must necessarily have been imperfect. If Mr. Anderson would be kind enough to furnish them with a series of papers upon a series of machines, they would no doubt be highly interesting. Col. Colt, he believed, was the first to introduce a series of machines for the manufacture of pistols and fire-arms generally, and these were as complete as they well could be. But in the application of that machinery, Col. Colt expressed the very difficulty to which Mr. Hobbs had referred.

Mr. THOS. WEBSTER, F.R.S., remarked that the speech of Mr. Hobbs could not fail to impress upon their minds the fact that it was more difficult to engineer men than to engineer matter. The account Mr. Hobbs had given of the difficulty which masters in this country experience in getting their workmen to adopt improvements in manufactures, as contrasted with the state of things in America, was very remarkable. The history of strikes showed how much of the invention of this country had been due to this cause, for many of the leading machines of the present day, the mule and others, and also Mr. Peter Fairbairn's machine for the treatment of flax, were due to the necessity which existed of getting rid of a class of workmen who at one stage controlled a series of operations. The statement of Mr. Hobbs upon this subject could be amply confirmed by all who were acquainted with the progress of invention in this country. Mr. Newton had mentioned the experience of Col. Colt as to the difficulty of getting skilled workmen to carry on the operations of his machines. He (Mr. Webster) could inform them of a similar occurrence in the establishment of Messrs. Ransome and May, at Ipswich. By means of the simplification of their machinery, the most ordinary unskilled men could now perform the work which was previously done by skilled labour. The subject of strikes had, on a former occasion, been profitably discussed by the Society, and it was a question which related more to the education of the people than perhaps any other with which he was acquainted.

Colonel O'Connor said, as a common fighting soldier in the bush, he would draw the attention of Mr. Anderson to two important weapons. It was very easy on Woolwich Common, with eight good horses and as many artillerymen, to dash off with heavy field-pieces, but when they got to Africa, conveying a gun through jungles, over swamps, and through deserts, it was a very different matter. In the last campaigns in Africa he had a 24-pounder gun; it required 40 horses to drag it and 80 negroes to move it, and after all it stuck fast. The best weapon he considered for that mode of warfare was the Congreve rocket, from 12 to 24-pounders; these were very successful in storming stockades, an operation which could be effected with success at a distance of 800 yards. Where guns were used in such a country they must be of a very light description, and easily transportable.

Mr. WINKWORTH said, that he rose rather to confirm an opinion given by his transatlantic friend, Mr. Hobbs, in the course of his speech, than to discuss any of the points arising out of Mr. Anderson's paper. The opinion

to which he referred was, that English workmen are indisposed to permit the introduction of improvements calculated to economise manual labour. He was sorry to say that his experience in early life as a silk manufacturer, fully bore out the proposition, so far as that branch of trade was concerned. He was old enough to recollect the introduction of the first factory for winding off dyed silks, so as to supersede the expensive and slow process of hand winding at home, when the owners were threatened with personal violence and the destruction of the building. Then came the wooden drawboy, which was held to be a dangerous substitute for the previous and slower method, and the Jacquard, which was a still greater innovation, against which all the strength of prejudice and numbers was arrayed. But if these were invasions on the rights of individual personal labour, it followed as a natural consequence, that power loom weaving was the climax of wrong inflicted by the hard-hearted employers on their suffering workpeople. What destruction of property and even loss of life attended the introduction of these and other improvements, was now matter of history, and he only regretted to be obliged to add that what was true of this branch of industry, applied more or less to the annals of improvement in almost every other. It followed, therefore, that operatives, though keeping pace to some extent with the intelligence of the age, were in their original ignorance as regards this point, and required instruction in that important section of political economy, which teaches the right use and the inestimable advantage of improvements in the science of frugality of labour. With respect to the many exquisite specimens of mechanical art on the table, the pleasure of admiration was much qualified by the painful consideration that they were devised with elaborate skill for the destruction of that which, under ordinary circumstances, we took so much pains to preserve, namely, the image of God as seen in human life. The only consolation which these frightful appliances for certain death afforded, arose from the argument that the greater and more immediate the slaughter the sooner the occasion for their use would cease. He could not sit down without expressing his thanks to the author of the paper, for the admirable epitome he had given them of the skill and ingenuity which had been so successfully displayed in the public department in which he was engaged.

The CHAIRMAN said it now remained for him to move a vote of thanks to Mr. Anderson for the very interesting, important, and valuable paper he had communicated to the Society. He had drawn attention to the wonderful development of machinery under his superintendence during the last few years. This country had now a great military arsenal, such as a great mechanical nation ought to be proud of, and perhaps there was no person to whom they were so much indebted for the efficiency of the machinery in this department as to Mr. Anderson. England was essentially a mechanical country, and it was our true policy to make our mechanical resources available for our military defences. This country had been found at the outbreak of war to be deficient in its preparations, but from what they had heard this evening, they had no reason to apprehend that such would be the case in the event of another war. He fully concurred in the observation contained in the paper, that the admirable machinery introduced into the war departments at Woolwich and elsewhere, had not only been attended with the most beneficial results as regarded the department itself, but would give a stimulus to the mechanical resources of this country. He hoped the details of this machinery would be communicated by Mr. Anderson at some future time, so as to enable the constructors of machinery to have the full benefit of the instruction which Mr. Anderson was so well qualified to convey.

A vote of thanks to Mr. Anderson was then passed.

The Secretary announced that, in consequence of severe domestic affliction, the Rev. W. Rogers

was unable to attend and read his paper as announced for next Wednesday, and that under these circumstances, a paper by Mr. Bashford, of Surdah, East Indies, "On Experiments with Silkworms, with a View to Improve the Present Silk Yields in Bengal," would be substituted for it.

PRIZE FINANCIAL ESSAY.

The following are the conditions relating to the competition for the prize of 200 Guineas, placed in the hands of the Council of the Society of Arts by Mr. Henry Johnson, to be awarded for "The best Essay on the present financial position of the country as affected by recent events, in which the principle of a sinking fund should be discussed, and also an investigation made as to the best mode of gradually liquidating the National Debt."

CONDITIONS.

1. The Essays to be sent to the Society of Arts by the 31st day of December, 1857. Each Essay to be marked "Finance Essay," and to have a motto or distinctive mark attached, which mark must also be written on a sealed letter, containing the name and address of the author.
 2. The Essays will be delivered by the Council of the Society to the adjudicators, who will fix a day for making their award, which will be more or less distant, according to the number and size of the Essays.
 3. The letters, containing the names and addresses of the authors, will remain with the Society of Arts, and none will be opened except that bearing the motto, or mark attached to the Essay to which the adjudicators award the Prize.
 4. The adjudicators shall not be expected to give any reasons for their award, beyond stating that in their judgment the Essay is the best that has been submitted to them upon the subject, and is worthy of the Prize, nor shall they be expected to give any opinion as to the soundness of any sentiment or theories which the Essay may contain.
 5. When the adjudicators are prepared to make their award, a special meeting of the Council shall be summoned, and the Chairman shall then open the letter which bears the motto or mark attached to the successful Essay, and the Secretary will then communicate with the author.
 6. That in case the author of the successful Essay shall be unwilling to print and publish the Essay at his own expense, then the copyright shall belong to the Council of the Society of Arts, who may publish the whole or any part of it, as they may think proper.
 7. That the unsuccessful Essays shall be returned to their authors when claimed, with the seals of the letters unbroken.
 8. That the number of the adjudicators to be appointed by the Council be three.
 9. The Council reserve to themselves the right of withholding the prize entirely, in the event of the adjudicators reporting that in their judgment no Essay sent in is deserving of the reward.
- * * Each Essay must be written in a plain legible hand, and only on one side of the paper, and it is recommended that it be as brief as is consistent with the importance of the subject.

BESSEMER IRON.

The following account of experiments in reference to this process conducted at the Coats Iron Works, Glasgow, by Messrs. Jackson and Company, will be read with interest:—

"The experiments were conducted, as nearly as possi—

ble, according to the method described to the public by the patentee. The form of the Bessemer furnace used was cylindrical, being 18 inches in diameter and with 6 tuyeres, each three-eighths of an inch in diameter, entering almost on a level with the bottom of the furnace. The pig iron used was one of the best brands of the firm, (Eglinton) and No. 1 or softest quality; the quantity operated on about 8 cwt. The pig iron when melted, in the ordinary foundry cupola, was run direct into the Bessemer furnace which had been previously well heated. The blast was then applied, and beginning at a pressure of 8 lbs. was raised during the process to 11 lbs. and afterwards allowed to descend to 5 lbs. The appearance of the action going on was similar to that usually ascribed to it; and when, from the subsidence of the ebullition and the change of flame to a purple colour, the process was deemed concluded, the metal was run off into moulds (18" X 4" X 4"). These blooms, after cooling, were reheated and rolled into bars, and these, cut up into equal lengths, were piled 9 high and again rolled into bars, the same mode having thus been pursued as that adopted to manufacture marketable iron. The iron was found quite unfit for commercial purposes from its brittleness. The per centage of loss was invariably much greater than by the old process, being as high as 17 per cent. above the usual waste."

Home Correspondence.

STEAM-SHIP ARITHMETIC.

SIR,—In a paper read by me at the meeting of the British Association at Cheltenham, in August last, on "Mercantile Steam Transport Economy," I brought before public notice that a system of steam-ship arithmetic might be based on the formula usually adopted for determining the co-efficient or index number of dynamic duty of steam-ships, namely, $\frac{V^3 D^{\frac{1}{2}}}{\text{Ind. H. P.}} = C$, the numerical values of "C" having been experimentally determined for vessels of the different types of build for which the arithmetical calculations may be required. This paper has led to many inquiries of me for more specific information as to the mode of applying the formula, such, for example, as the letter of "Inquirer," in the *Mechanics' Magazine*, No. 1,745, who says, "I shall feel obliged if Mr. Atherton will inform me whether by the co-efficient of dynamic performance he means the useful effect, or if not, what it refers to." I am glad to find that the subject "Steam-Ship Arithmetic," based on the mutual relation of displacement, power, and speed, as dependent on the locomotive or dynamic qualities of the vessels employed to do the work of mercantile transport service, and for which in the end the public have to pay the cost, whether done ill or well, the difference between doing the work ill or well involving probably millions per annum, is now at length attracting public attention. I have, therefore, much pleasure in responding to the inquiry thus publicly made, by explaining the views which I entertain, defining, to begin with, that V is intended to express the speed in knots or nautical miles, of 2,028 yards per hour, D the displacement expressed by the number of tons weight of water which the hull of the vessel displaces at the time of trial, allowing 35 cubic feet of water to the ton, and Ind. h. p. is the gross working power as measured by the unit equivalent to 33,000 lbs. raised one foot high per minute. Hence the co-efficient "C," or index number x , is a mere numerical indication, which will be a constant number for vessels of the same type, but not necessarily a constant number for vessels of different types. It, therefore, when deduced from vessels of different types, becomes a series of index numbers " x ," whereby we may be able to compare the adaptation of ships of dissimilar type for the

performance of gross locomotive or dynamic duty, including the locomotion of the respective ships themselves, propelled by the engines at such rate of speed as may be, and in all this it is supposed that the net effective power of the engines is in a constant ratio to the gross indicated power. The numerical values of the co-efficients or index numbers (x) being thus practically ascertained by the actual trial of ships of known constructive elements or types of build, the index number of any particular ship may then be applied as a constant number, not to vessels indiscriminately, but to vessels of *similar types of immersed form*, whatever be the immersed displacement "D," intended speed "V," or intended working power "Ind. h. p.," thus completing the equation $\frac{V^3 D^{\frac{1}{2}}}{\text{Ind. h. p.}} = C$,

from which any two of the three quantities, V, D, and Ind. h. p., being given, the third may be found, as will be hereinafter exemplified. It is thus only by having ascertained the co-efficients or index numbers actually realised by vessels of known types that we are enabled to assign the co-efficient that an intended vessel about to be constructed may be expected to realise. It is my conviction that neither mathematical investigation nor legislative intervention, will by itself alone be adequate for realising perfection in naval construction. Experience must be resorted to and made available as above set forth, but I believe that mathematical investigation, combined with a complete system of statistical registration, giving us the ordinary load displacement of ships, and the available working power of steam ships expressed by their indicated power, or any other definite unit, will do a great deal towards enabling us to realise, appreciate correctly, and bring to book, the results of experience, and thence by an analysis and comparison of the distinctive elements of dissimilar vessels, of which, in each case, the index number has been determined, we may be led to discover and adopt those elements of build which conduce to efficiency for any particular service, and reject all dogmas thus found to be practically ill adapted for the production of dynamic efficiency. Such is the primary use of the formula $\frac{V^3 D^{\frac{1}{2}}}{\text{Ind. h. p.}} = C$. It enables us to assign defi-

nite index numbers or numeral values to the performance of steam-ships, instead of the general panegyrics in which the trial performances of new steam-ships are usually spoken of. The co-efficients "C," or, as I have called them, the index numbers (x), produced by vessels of dissimilar types and of dissimilar engine-construction, vary greatly. The index number " x ," is sometimes as low as 120, frequently as low as 150, it frequently reaches 200, and in some cases the index number 250 is said to have been attained. I believe that at the present time it is more frequently below 200 than above that number, and as the index number is affected not only by the type of form and smoothness of the hull at time of trial, but is also dependent on the greater or less efficiency of the engines (for the Ind. h. p. is the measure of the gross power, not of the net effective working power of the engines), it is evident that in the case of a vessel not realising so high an index number as may have been expected from her type and form, it will become a subject of professional inquiry whether the deficiency be attributable to the hull or the engines.

It is further an important matter in favour of this principle of determining the comparative locomotive *merits* of steam-ships, that by substituting the consumption of coal "W" expressed in cwt. per day of 24 hours, the merchant will have the means based on his own Counting-house data of testing the performance of his steam-ships and of determining whether the success or failure of any particular service may be attributable to the constructive qualities of the vessel or to her mercantile management. This view was brought forward in my essay on "Steam Ship Capability," 2nd edition, appendix No. 4, and on this matter I observed in my Cheltenham paper as follows:—

"Further, this formula may be rendered available as a Counting-house check on the working operation of steam-ships, simply by substituting the consumption of coal expressed in cwts. per day of 24 hours "W" in lieu of the Ind. h. p.; for, one cwt. or 112 lbs. per day of 24 hours is at the rate of 4.66 lbs. per hour, which is probably about the ordinary consumption per Ind. h. p. per hour, and it ought not to be exceeded. If, therefore, in lieu of the Ind. h. p., we substitute the consumption of coal calculated in cwts. per day of 24 hours, the resultant coefficient "C" will afford an approximate indication of the good or bad performance of ships as compared one with another, and the fact of an inferior performance being thus detected, the cause to which it may be attributable, whether to inferior type of form or foulness of bottom, or inferior adaptation of engine, or inferior construction of boiler, or inferior management on board of ship, will then become the subject of professional inquiry: thus, the merchant, by aid of his Counting-house statistics of displacement, time on passage of given length, and coal consumed, will be enabled to detect the fact of inefficiency, and it will then be for the professional engineer to detect and remedy the cause thereof. The enunciation of the formula, or the mercantile rule above referred to, is as follows:—Multiply the cube of the speed, expressed in knots or nautical miles per hour (V^3), by the cube root of the square of the displacement ($D^{\frac{2}{3}}$), and divide by the consumption of coal, expressed in cwts. per day of 24 hours, the resultant numeral coefficient "C" will indicate the dynamic or locomotive efficiency of the vessel; and such is the variable condition of steam-ships in present use, that the coefficient has been found to be as low in some cases as 120, whilst in other cases it has reached the number 250."

Now, as an example of the application of the formula $V^3 D^{\frac{2}{3}} = C$: suppose a vessel about to be constructed Ind. H. P. 175 feet length on deep draught water line, 25 feet breadth, and 10 feet draught of water exclusive of keel, to be built on lines which give a displacement of 500 tons at the draught referred to, and that from previous experience of the type of build or comparison with vessels of a similar type, we have reason to expect that the coefficient or index number will be 200, and we wish to know what amount of Ind. h. p. will propel the vessel at the speed of 14 nautical miles per hour.

In this case $\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H. P.}} = 200$, or Ind. h. p. = $\frac{V^3 D^{\frac{2}{3}}}{200}$
 $= \frac{(14^3) 500^{\frac{2}{3}}}{200} = \frac{2,744 \times 63}{200} = 864$ Ind. h. p. That is, the engines, whatever may be their *nominal* power, must be capable of working up to 864 Ind. h. p. to propel the vessel at the speed of 14 *nautical miles* or knots per hour.

If the intended speed be 14 *statute miles* per hour, which is equal to 12.15 knots, then we have Ind. h. p., $= \frac{(12.15^3) \times (500^{\frac{2}{3}})}{200} = \frac{1,794 \times 63}{200} = 565$ Ind. h. p., being 300 Ind. h. p. less than is required to attain the speed of 14 *nautical miles*, and yet "miles" are frequently spoken of without any distinction being made as to whether nautical miles or statute miles are intended.—I am, &c.,

CHARLES ATHERTON.

Woolwich Dockyard, Jan. 27, 1857.

HUMAN LONGEVITY IN AMERICA.

Sir,—In an article on "human longevity," in the last "Edinburgh Review," I find the following sentence, so far confirming my views of the condition of the white races in the United States:—

"From Professor Tucker's analysis of the American Census, from 1790 to 1840, published a year ago, we derive the strange result, if true, that the chances of living to above 100 years are 13 times as great amongst the slaves, and 40 times as great in the free negroes, as in the white population of the country."—I am, &c.,

W. BRIDGES ADAMS.

VEGETABLE FIBRES.

Sir,—The paper recently read at the rooms of the Society, by the hon. and learned gentleman, the Chief Justice of Honduras, embodying, as it did, an important mass of information, historical, geographical, statistical, and commercial, on the affairs of that colony, extended to a length by no means disproportionate to its value, but tending to limit the discussion which generally succeeds to the perusal of the leading object of the night's meeting. The late hour at which I was enabled to offer a few observations upon one branch of the question, necessarily compelled me to restrict them within the least possible compass. The question of colonial vegetable fibres, to which I exclusively addressed myself, is one, the importance of which is only beginning to be understood in this country, and whatever may be calculated to throw a light upon the subject, I cannot but regard as falling naturally within the scope of the views of the Society, and I shall be glad to find that you can afford space for an attempt to show the real value of the question.

In the consideration of matters of this nature, suggesting, as in the present case, measures calculated to effect considerable changes in affairs of a commercial character, it is well to show the bases of operation, and fairly to consider the consequences on all sides.

Putting out of view, for the moment, that important subject, cotton, at present the leading fibre of the world, I shall limit my observations to those classes of fibre which partake of the character of flax and hemp, as being calculated to substitute, to a considerable extent, new materials adapted to all the purposes for which flax and hemp have been, until recently, exclusively employed.

In treating this question I must necessarily make special reference to the trade of Russia, as it will be seen that the chief imports of those commodities have ever been from that country. For this purpose, and to show the growing nature of those imports, I need not travel further back than the present century, and, under each head of flax and hemp, I will give the imports from 1801 to 1853, divided into five decennial periods and the three concluding years, the last of these dates being the year before the commencement of the late war. It will be seen that I give the total imports and annual averages for each period, and first for flax:—

FLAX IMPORTED FROM RUSSIA FROM 1801 TO 1853.

YEARS.	Total Import in each period.	Annual average in each period.
	Tons.	Tons.
1801 to 1810	147,118	14,712
1811 to 1820	144,301	14,430
1821 to 1830	271,325	27,132
1831 to 1840	372,700	37,270
1841 to 1850	498,781	49,878
1851 to 1853	153,170	51,057
Totals and averages in 53 years	1,587,395	29,951
Imported from all other parts in 53 years	665,027	12,547
Grand totals and averages for 53 years ...	2,252,422	42,498

At the low average price of £40 per ton for the whole term, the total value of flax imported in the 53 years was—

£90,096,880
 Of which came from Russia ... 63,495,800
 Leaving, from all other parts... 26,601,080

Of the portion imported from other countries than Russia, nearly the whole was from Holland, Belgium, and Prussia.

I will next proceed to show the state of the trade in hemp for the same term of 53 years:—

HEMP IMPORTED FROM RUSSIA FROM 1801 TO 1853.

YEARS.	Total Import in each period.	Annual average in each period.
	Tons.	Tons.
1801 to 1810	326,062	32,606
1811 to 1820	266,186	26,619
1821 to 1830	242,955	24,295
1831 to 1840	288,657	28,866
1841 to 1850	280,924	28,092
1851 to 1853	100,405	33,468
Totals and averages in 53 years	1,505,189	28,400
Imported from all other parts in 53 years	324,102	6,115
Grand totals and averages for 53 years ...	1,829,291	34,515

At an annual average rate of £35 per ton, for the whole term, the value of hemp imported from Russia, in the 53 years, was £52,681,615.

I do not here compute the value of the remaining portions of the articles imported elsewhere than from Russia, which, although not all strictly hemp, are brought under that head in the official accounts from which the above figures are taken. There are certain limited quantities of actual hemp brought from various European countries, and a considerable quantity obtained from a species of the plantain tree, grown in the Philippine Isles, and imported under the name of Manila hemp. But the chief imports now, other than from Russia, are from our East Indian possessions, amounting to considerably above 20,000 tons a year, a portion of which is Sunn and Bombay hemp, but chiefly jute, articles which, a few years ago, were scarcely known in this market.

Returning now to Russia, I have shown that the value of flax imported from thence, during the last 53 years, was—

	£63,495,800
And of hemp	52,681,615
Together	£116,177,415

Being an average of above two millions a-year for the whole period. But, taking the last 20 years, the flax and hemp imported from Russia has been of the average value of fully three millions sterling a-year. This sum, however large, constitutes but about one-third of the total value of our imports from thence, which have averaged, for some time past, from eight to ten millions per annum, whilst, within the same period, the value of British and Irish produce and manufactures exported to that country has been under £1,200,000 per annum.

I stated at the recent meeting, that the island of Jamaica, and colony of British Guiana, being the colonies to which my attention has been more immediately directed (to which I added Honduras, then under discussion), were capable of producing every pound, in fibres of various kinds, suited to almost every purpose to which Russian flax and hemp can be applied, and, in many cases, far superior in quality to those products which constitute the value of three millions a-year, or the full amount of our imports from Russia of those commodities. I made that statement advisedly, and I adhere to it. And I may ask, if the welfare of our colonies be an object of interest in this country, how it happens that so large a source of wealth as this branch of industry is capable of providing should have been so strangely overlooked?

I have been long of opinion that our West India colonies have been grossly neglected. To use a familiar phrase of our north-country brethren, "the cold shoulder has been given to them" with a vengeance; and possessions, the value of which will be discovered if we should ever have the misfortune to lose them, are most unquestionably deserving of a much higher degree of aid and encouragement than it has been the practice, of late years, to afford them.

To illustrate the question of the value of the British

colonies, I will very briefly give the results of a carefully compiled and comprehensive statement, which I drew up, in the year 1849, for the trade of the preceding year, with a view to satisfy myself of the comparative value of the home and colonial, as contrasted with the foreign, consumption of our manufactures and produce. I took, on the one side, every foreign country of the world, except China; and, on the other side, all British colonial possessions, except the East Indies, placing those possessions against China, on the foreign side. With these two exceptions, the result was, that all the foreign countries of the world took from us an average value of 2s. 2d. per head of their populations, whilst the British colonies, considered alone, took at the rate per head of twenty times that amount; but taking, conjointly, the home and colonial trade against the foreign, the rate of consumption per head of the united population was above fifty times that of foreign countries.

In this statement, Russia figures, as a consumer of our products, for the large sum of 8d. per head of her population. But such has been the decline from even that low rate, in her imports from this country since that date, that her present consumption of our products (I here speak of the years 1851, 1852, and 1853), has fallen to barely 5d. per head, being below the rate of any other country in the world.

It may be said that, since 1848, such has been the enormous increase of our exports, that a computation such as I have here referred to, is of no present value. Granted, the immense increase. But our colonies have maintained their full proportionate rate of advance since 1848; and I will now venture to make a statement—challenging a denial of its accuracy—that, whilst the consumption of all foreign countries, excepting China, is, at present, below 3s. per head, that of the British colonies, excepting India, maintain the proportion of twenty times that rate. If this be so, then surely colonial interests are worth the fostering to a much greater extent than it has been lately applied to them. And there—not to extend my communication, already too long—I will leave the question.

Yours, &c.,

J. B. SHARP.

44, Myddelton-square, 16th January, 1857.

VENTILATION.

SIR,—The principles on which good ventilation depend have been long well known, yet in practice they are rarely adhered to. They consist in the supplying a sufficiency of fresh air for respiration—the getting rid of that which has been vitiated, and the avoidance of draughts of cold air.

In manufactories these principles were carried out by the late Mr. William Strutt, and at the Panopticon, near Petersburg, and proved to be efficacious and economical. The late General Sir Samuel Bentham recommended that navigable vessels should be provided with pipes for the admission of fresh air, besides those for the exit of that which had been vitiated.—(See "Naval Papers," No. VI., p. 49.) Yet, even in emigrant ships the ventilation is only effected by opening the doors and windows. Lately, a manufacturer has invented the means of heating air behind a common grate, which process effects the ventilation at a cheap rate. The life of persons condemned to earn their livelihood in close rooms, has been much commiserated, but the immediate effects of such confinement might be greatly mitigated by the ventilation of their workrooms. Dr. Arnott's air pump might conveniently be used to keep up a constant current of heated air for this purpose, and might be set in motion by clock work, or even by a common kitchen jack.—I am, &c.,

M. S. BENTHAM.

26, Wilton-place, January 24.

Proceedings of Institutions.

BEXLEY HEATH.—The Society for the Promotion of Useful Knowledge has just held an exhibition of Works of Art and Science, as well as curiosities of general interest, which commenced on Tuesday, the 6th, and continued for the next three days. This Society possesses a library of some 500 volumes, and is the medium by which lectures and concerts are given to the neighbourhood throughout the winter. Last year its managers got up a very creditable exhibition, but this year they have succeeded in making great advances upon the last. The kindness of the surrounding gentry in lending their most valuable paintings, models, and gems of every description, is deserving of imitation throughout the country. Over and above the paintings, which lined the walls of the large Boys' School-room, several of which were of great value, there was a very beautiful statue of Psyche, belonging to Oswald Smith, Esq., several fine bronzes, including the "Dying Gladiator," Jacquard-loom specimens, choice Bohemian glass, Chinese and Indian curiosities, North American Indian dresses and manufactures, a seal-skin dress and cap of a sailor of the *Resolute*, Crimean trophies, and other objects of interest, including a most beautifully illuminated missal, in perfect preservation, the model of a royal Burmese war-junk just brought to England, and the interesting metal aluminium, and a most elegant chess-table exhibited in 1851 at Hyde-park. The Society, being in connexion with the Society of Arts, had the benefit of a large number of photographs (besides a quantity of scientific apparatus), and especially of the new photogalvanographic engravings, which were universally appreciated. In addition to these, there were stereoscopes of various kinds; whilst several microscopes, under the superintendence of Flaxman Spurrell, Esq., afforded much gratification.

BIRMINGHAM.—A *soirée*, in connexion with the Birmingham and Midland Institute, was held on Friday evening the 23rd inst., at the Music-hall, Birmingham. The attendance was numerous, and included the Rev. Dr. Badham, Mr. A. Ryland, and Mr. John B. Hebbert, Vice-Presidents of the Institute; Dr. Bell Fletcher, the Rev. A. O'Neil, the Rev. Mr. Hodgkinson, Alderman Manton, Mons. Achilles Albites, Mr. Joseph Gillott, Councillor Holland, Councillor T. Osborn, Councillor E. C. Osborne, Mr. J. Hinks, Mr. W. Mathews, jun., Mr. Wiggan, Mr. S. Timmins, Mr. W. C. Aitkin, Mr. Everitt, Mr. J. S. Dawes, Mr. George Shaw, Mr. Henshaw, Mr. A. Kenrick, Mr. Charles Clifford, Mr. George Downing, Mr. P. Hollins, Mr. Howell, Mr. George Jabet, the Rev. J. M. Aston, Mr. W. R. Lloyd, Mr. W. M. Williams, Mr. Ball, Mr. Prime, Mr. Prime, jun., Mr. Green, Mr. Whitworth, Mr. Barker, Mr. T. C. Saunders, Mr. Whitehouse, Mr. T. P. Salt, Mr. M'Callum, Mr. F. Elkinton, Mr. Forbes, Mr. Horton, Mr. Chambers, Mr. W. Barlow, Mr. J. D. Goodman, Mr. A. Morgan, Mr. Dixon, Mr. Hill, Mr. J. F. Griffiths, Mr. W. Morgan, Mr. Radclyffe, Mr. Shakespeare, Mr. B. Smith, Mr. R. Heaton, Mr. S. Findley, Mr. C. M. Ingleby, Mr. R. T. Chance, Mr. R. L. Chance, jun., Mr. J. Dotterill, Mr. J. Syson, Mr. R. B. Taylor, Mr. P. Hollins, Mr. Henry Williams, Mr. Southall, Mr. S. Goddard, Mr. Blakemore, Mr. Davis, Mr. E. Heeley, Mr. T. Martineau, Mr. J. C. Woodhill, Mr. J. J. F. Winfield, Mr. W. H. Reynolds, Mr. Deykin, and many others. Colonel Sykes, chairman of the East India Company, and Chairman of Council of the Society of Arts, with whom were Mr. Sheriff Mechi and the Rev. Dr. Booth, attended as a deputation from the Society of Arts, to explain the system established by the Society for the examination of students attending classes at Literary and Scientific Institutions, and for awarding prizes and certificates to meritorious candidates. Mr. Ryland, one of the vice-presidents, presided, and, in the course of his opening address, alluded to the benefits

which would accrue from the Institute being taken into union with the Society of Arts—an important step, as it would secure for the industrial department valuable privileges. There was also a letter from Mr. M. D. Hill (Recorder of Birmingham), in which he expressed his regret at being unable to attend, and his hearty wishes for the success of the Institute. The Rev. Dr. Badham spoke a few words to the classes for whose advantage the Institute had been established, and the Chairman then proceeded to deliver the certificates to the successful pupils; to Herbert Brown, for proficiency in physics; to C. J. Woodward, for the same; and to Joseph Lucas, Thomas Griffiths, and Newton Walsh, for proficiency in chemistry. In presenting the certificates he commented upon the high compliment which was conferred upon them in being the first recipients of honourable distinction, and trusted that they would make the Institute proud of them. Colonel Sykes, chairman of the Council of the Society of Arts, said they were all aware of the liberal feeling which pervaded the whole country, that all classes of society should have their intellectual faculties advanced and strengthened. They saw throughout the kingdom the efforts which were being made on behalf of the operative classes, and they only wished that those efforts might be successful. Mechanics' Institutions effected much good in supplying links in the chain which was broken in infancy, and their object was to impart a knowledge which might be of use to the recipients. He was followed by the Rev. Dr. Booth who said that a few years ago the Society of Arts, flushed with the success of the Great Exhibition of 1851, turned its attention to the consideration of how it could still further benefit the country; and it appeared to the Council that if the different institutions for the working classes throughout the country could be brought to combine together, great advantages would result. This union had been most successfully effected—a proof that the people were disposed to place confidence in that body in which the Great Exhibition had originated. Dr. Booth then gave some account of the origin and results of the Society's Examinations, and afterwards proceeded to address those young men who were preparing to come up to their examinations in London this year, for next year he hoped the centres of examination would not be confined to London, but that, if Birmingham was willing, they would hold examinations there. The Society hoped to be able to spread their operations all over the country, so as to hold out inducements to the whole community to turn their attention to intellectual acquirements, and take them away from sensual enjoyments. He looked upon the efforts of the Society of Arts as inaugurating a great educational movement. The examiners were not particular as to where the knowledge was acquired. Their sole object was to ascertain that they possessed that knowledge. And just as if a person were to take a handful of genuine Australian nuggets, and, walking down Birmingham streets, would not find a single buyer if he offered them for a few pence, whereas if he took them to the Mint and had them stamped with her Majesty's head, he would soon find a ready market for them—so with these young men who came up to London, they, the rough nuggets of precious ore, might not be known or appreciated until they had stamped upon them the test of the Society's examiners, when it was to be hoped they would be received as gladly as the bright sovereigns from the Mint, and be treated accordingly.—Mr. MECHI next addressed the company, and was followed by Mr. FAIRBAIRN, of Manchester, who moved a resolution in favour of the examinations, which was seconded by Mr. J. F. WINFIELD. Speeches were subsequently delivered by Mr. Scholefield, M.P., the Rev. Mr. Dale, Mr. Buckmaster, and other gentlemen; and a vote of thanks was passed to the deputation from the Society of Arts for their attendance. Colonel Sykes, in acknowledging the compliment, assured the meeting that the deputation had not come to Birmingham to ad-

vocate the cultivation of the intellects of its operatives upon the principle of material advantage alone.

BURY.—The fourth annual meeting of the members of the Bury Athenæum was recently held in the large hall of the Institution. John Robinson Kay, Esq., of Bass-lane House, the president of the Institution, occupied the chair. In commencing the proceedings, the Chairman said he had pleasure in meeting the members once more at the annual meeting of the Institution, which was one of some importance, inasmuch as the report of the directors for the past year would be read. He called upon Mr. Joseph Pomfret, the secretary, to read the annual report, from which it appeared that during the first quarter there were 429 adults, 94 juniors, 58 females, 68 annual, 35 life, and one honorary, making a total of 685 members. In the same quarter in 1855 the number was 761. In the second quarter there were 400 adults, 103 juniors, 50 females, 69 annual, 35 life, and one honorary, making a total of 658 members. In the corresponding quarter of 1855 the number was 688. In the third quarter there were 357 adults, 73 juniors, 33 females, 70 annual, 35 life, and one honorary, making a total of 569, against 599 in 1855. In the fourth quarter there were 435 adults, 123 juniors, 63 females, 70 annual, 35 life, and one honorary, making a total of 727. In the same quarter in 1855, the number was 674, thus showing an increase of 53 members. The demand upon the books in the library during the past year has been greater than at any previous period since the opening of the Athenæum. An annual subscription of five guineas had been paid for the privilege of receiving a selection of the newest works from Mudie's library. The Ellesmere box of biographical works had also been received from the Lancashire and Cheshire Institutional Association. During the year, 47 volumes of new and popular works had been purchased, which, together with 19 volumes which had been presented, caused a permanent addition to the library of 66 volumes. The following are the issues during the year:—History, antiquities, biography, and anecdotes, 2,091; geography, voyages, and travels, 769; mathematics, natural philosophy, and natural history, 879; fine arts, useful arts, social and domestic economy, 499; mental and moral philosophy, philology, criticism, and political economy, 471; poetry and the drama, translations from Greek and Latin classics, 338; novels, tales, miscellaneous and collected works, literary and scientific periodicals, 6,589; giving a weekly circulation of 232 volumes. Arrangements were made for a course of lectures to be delivered by different gentlemen, but the lectures failed to attract the public, and the result was a loss to the Institution. The news-room had been preserved in a most efficient condition, and had had the effect of attracting new subscribers. In the early part of the past year, one cheap concert was given under the auspices of the directors, the result of which was very satisfactory. The direction of the concerts has since been changed, the choir having them now under their own control entirely, and simply hiring the hall for the performances. During the year elementary singing classes have been established; the advanced class now numbers forty, and the junior class twenty-five members. There was a debt on the building amounting to £517 4s. 8d., and an effort had been made to raise by subscription the amount required for its liquidation. The sum of £339 1s. had been promised towards the object. The following classes are now in operation: adult writing and arithmetic class, 54 members; junior ditto, 75; female ditto, 15; French class, 14; English grammar, 29; instruction in fine arts, 13; ornamental drawing class, 12; female ditto, 3; mechanical ditto, 21; general ditto, 15; singing class, 65; choir, 60; chemistry, 4; total number of members in the classes, 315.

LEIGHTON BUZZARD.—A lecture was delivered at the Town-hall, in connection with the Literary and Scientific Institution, on Wednesday evening, by Joseph Simp-

son, Esq., of London, (late Librarian of the Islington Literary and Scientific Society,) on "The Life, Character, and Times of Henry VIII." The first part of the lecture treated of those traits in the monarch's character which were most conspicuous during the early part of his reign, among which his vanity and love of pleasure were especially prominent. A description of his court was then given, and the unbounded influence of Wolsey over the king also noticed. The character of the Cardinal was next very ably dwelt upon. The question of the divorce, and the circumstances in connection with it, then followed, in which the characters of Anne Boleyn, Jane Seymour, and the other wives of Henry the Eighth, the king's conduct in reference to the divorce, and his cruel and unjustifiable treatment of his various wives, were discussed at some length. The manner in which this part of the subject was handled, and the sentiments and reflections with which it abounded, were received with unmistakable expressions of approval by the audience. Mr. Simpson next drew attention to the origin, progress, and results of the Reformation, considering its bearing, not only upon that age, but tracing its inestimable benefits down to the present time. In conclusion, the lecturer briefly but impartially summed up the character of Henry the Eighth. Although this lecture occupied an hour and a-half in delivery, the attention of a large and highly respectable audience was sustained and riveted to its close.

ROYSTON.—At the Institution on Friday evening, 23rd January, W. Parker Hamond, jun., Esq. (of Pampisford Hall), delivered an interesting lecture, entitled "Notes of a Tour in Spain and a Residence in Barcelona during the Insurrection of the Past Year." The members of the Institute are deeply indebted to Mr. Hamond for his generosity in thus allowing them to profit by his travels.

MEETINGS FOR THE ENSUING WEEK.

- MON.** Royal Inst., 2. General Monthly Meeting.
London Inst., 7. Mr. Charles Salaman, "On the History of Music, especially in connection with National Dances."
Entomological, 8.
Chemical, 8.
- TUES.** Royal Inst., 3. Prof. Huxley, "On the Sense of Hearing."
Civil Engineers, 8.
Linnæan, 8.
Pathological, 8.
- WED.** London Institution, 3. Mr. E. W. Brayley, "On Mineralogy and Crystallography."
Society of Arts, 8. Mr. F. Bashford, "On Experiments with Silk worms, with a view to improve the present silk yieldings in Bengal."
Geological, 8. 1. Mr. Cleghorn, "On the Formation of Rock Basins." 2. Mr. Rubridge, "On the Copper Mines of Namaqualand, South Africa."
Pharmaceutical, 8½.
Royal Soc. Lit., 8½.
- THURS.** Royal Institution, 3. Prof. Tyndall, "On Sound."
Zoological, 3.
Philosophical Club, 5½.
London Institution, 7. Dr. R. E. Grant, "On the Natural History of Extinct Animals."
Antiquaries, 8.
Philological, 8.
Photographic, 8. Anniversary.
Royal, 8½.
- FRI.** Archeological Inst., 4.
Royal Inst., 8½. Dr. J. H. Gladstone, "On Chromatic Phenomena, exhibited by transmitted Light."
- SAT.** Asiatic, 2.
London Institution, 3. Mr. T. A. Malone, "On Experimental Physics, chiefly in Relation to Chemistry."
Royal Institution, 3. Prof. Phillips, "On Successive Lands and Seas."
Royal Botanic, 3½.
Medical, 8.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[From Gazette, January 23rd, 1857.]

Dated 21st November, 1856.

2762. William Jacobs, Albert-road, Globe-fields, Mile-end—An improved composition for bedding and rendering bricks in furnaces.

Dated 8th December, 1856.

2903. Charles John Lewsey and George Nasmyth, Bucklersbury—Improvements in the treatment and application of woods used in the construction of casks and such like vessels, and for other purposes.

Dated 6th January, 1857.

51. Charles Emilius Wright, Green-street, Blackfriars—Improvements in preparing lubricating compounds.

Dated 1th January, 1857.

57. Charles Frederick Claus, Latchford, Cheshire—Obtaining tin or compounds of tin from the scraps or clippings of tinned sheet iron.
 58. James Morris, New Kent-road, Surrey—Improvements in washing machines.
 59. Peter Pilkington and Thomas Entwisle, Accrington, Lancashire—Improvements in machinery or apparatus for washing, cleaning, agitating, grinding, polishing, or mixing various materials.
 60. William Joseph Curtis, 1, Crown-court, Old Broad-street—Improvements in railway axle-tree boxes.
 61. William Young Smith, 77, Sydney-street, Sheffield—An improvement in sawing all kinds of wood.
 62. Henry Charles Hill, Croydon, Surrey—Improvements in screw and lifting jacks, and in machines for lifting, pressing, and lowering.

Dated 8th January, 1857.

63. George Pate Cooper, Walworth, Surrey—Improvements in the manufacture of shirt collars.
 65. Rupert Newton, Birmingham—A new or improved manufacture of metallic boxes.
 66. Wright Prestwich, Oldham—Improvements in gas burners.
 67. Edward Joseph Hughes, Manchester—Improvements in the manufacture and application of compounds resembling gutta percha and caoutchouc, from flour, fibrine, gelatine, and other vegetable and animal substances. (A communication.)
 68. James Harris, Hanwell, Middlesex—An improved lock, and method of acting upon lock-bolts, latches, taps and valves, railway and other signals, bells, and other like apparatuses.
 69. Alexander McDonald, Polished Granite Works, Aberdeen—Improvements in the manufacture of columns, pilasters, and other similar structures of granite, marble, porphyry, jasper, serpentine, sienite, and other stones capable of receiving a high polish.
 70. Thomas Lawes, 77, Chancery-lane—A machine or apparatus to be used in cleansing, purifying, and drying animal and vegetable substances.
 71. Thomas Ball and John Wilkins, Nottingham—Improvements in manufacturing looped fabrics, suitable for the making of gloves and other articles.
 72. John James Russell, Wednesbury, and Joseph Bennett Howell, Sheffield—Improvements in the manufacture of steel tubes, applicable to the flues of steam boilers and other uses.
 73. Thomas William Keates, Chatham-place—Improvements in the treatment of Rangoon naphtha, and other varieties of petroleum.
 74. John Roberts, Upnor, Kent—Improvements in the stoppering or closing of jars, bottles, and other vessels, applicable also to the joining of earthenware and other pipes.
 75. Robert Turnbull, Harwich—Improvements in cradles for heaving up ships.

Dated 9th January, 1857.

76. John Rock Day and Joseph Lester Hinks, Birmingham—Improvements in constructing and attaching knobs and handles of drawers and doors, cupboard turns, and other such like articles.
 77. John Henry Johnson, 47, Lincoln's-inn-fields—Improvements in machinery or apparatus for sewing or uniting and ornamenting fabrics. (A communication.)
 78. Robert Smith, Longridge, near Preston—Certain improvements in the manufacture of corded skirtings and corded petticoats.
 79. John Henry Johnson, 47, Lincoln's-inn-fields—Improvements in the application of the electrotype or galvano plastic processes. (A communication.)
 80. John Anderton Carruthers, Over Darwen, near Blackburn—Improvements in the mode or method of forming the lease or shed in sizing, warping, or weaving.
 81. James Hardacre, Manchester—Improvements in machinery or apparatus for preparing cotton, wool, and other fibrous substances to be spun.
 82. Joseph Gibbs, Abingdon-street, Westminster—Improvements in extracting gold and silver from their matrices and from other substances or materials with which they are combined, mixed, or associated.

Dated 10th January, 1857.

84. John and Christopher Gratrix, Preston—Improvements in looms.

85. Louis Julien Brethon, Tours, France—Improvements in machinery for manufacturing draining pipes, bricks, tiles, and all other similar plastic articles.

86. David Dunne Kyle, Albany-street, Regent's-park—A method of retarding or stopping railway trains and carriages, applicable also to carriages on common roads.

87. John Adams, 13, Ivy-cottages, Queen's-road, Dalston—A Minié or other rifle-sight on a new and improved plan.

88. John Chanter, Borough-road, and John Wakefield, Suchcore, Dublin—Improvements in the fire-boxes or furnaces of locomotive engine boilers.

89. James Hodgson, 16, Sweeting-street, Liverpool—An improvement in constructing wrought iron masts, yards, bowsprits, and other ships' spars.

90. Francis Xavier Kukla, Raven-row, Mile-end-gate—Improvements in apparatus for heating stoves by gas.

91. Charles Richard Olliffe, Park-lane, and James Anning Gollop, New Oxford-street—Improved apparatus for cleaning knives.

93. Paul Desruets, Paris—Improvements in purifying gas.

94. William Watt, Belfast—Improvements in treating or preparing Indian corn and other grain and amylaceous vegetable substances for fermentation and distillation.

95. Richard Archibald Brooman, 166, Fleet-street—Improvements in galvanic batteries and in apparatus connected therewith. (A communication.)

96. Richard Archibald Brooman, 166, Fleet-street—Improvements in propelling ships, boats, and other vessels. (A communication.)

Dated 12th January, 1857.

97. Benjamin Biram, Rotherham, Yorkshire—Improvements in machines for washing coal and other minerals.
 99. Arnold Goodwin, 69, Guildford-street—An improvement in fixing the tubular flues of steam boilers.
 101. Uriah Scott, Camden-town, and Frederic Holdway, Bayswater—Improvements in the manufacture of metal type, and the arrangement of the same for various purposes.
 103. Richard Chimes, Rotherham, Yorkshire—Improvements in apparatus for regulating the pressure of fluids.

Dated 13th January, 1857.

105. John Hinks and George Wells, Birmingham—An improvement or improvements in metallic pens.

WEEKLY LIST OF PATENTS SEALED.

January 23rd.

1741. Ferdinand Potts.
 1742. John Onions.
 1748. Henry Doubleday.
 1754. James Ashman.
 1758. George Collier and John Crossley, and James William Crossley.
 1770. Thomas Wrigley.
 1772. Samuel Jay and George Smith.
 1776. Julien Denis.
 1778. Charles Hodges.
 1783. Henry Remington.
 1857. Wm. Hall, Elisha Wyld, and William Waite.
 1884. Peters-Armand le Comte de Fontainemoreau.
 1896. William Church and Henry Whiting Hamlyn.
 1920. Philippe Pierre Hoffmann.
 2482. George Chappell Potts.
 2758. Charles Tooth.

January 27th.

1786. Henry Robinson.
 1787. Edmund Eaborn and Matthew Robinson.
 1791. William Griffin and Elizabeth Duley.

1819. John Watkins Brett.
 1823. Eugene Perre Chevalier.
 1839. Josiah Firth and Joseph Crabtree.
 1849. Alfred Vincent Newton.
 1867. Joseph Leese, Junr.
 1871. William Edward Newton.
 1881. Archibald Lockhart Reid.
 1885. John Cartland.
 1907. John Burns Smith.
 1921. Louis Auguste Joyeux.
 1930. Andrew Peddie How.
 1931. Charles Marie Chouillou.
 1937. Robert Jobson.
 1941. William Edward Newton.
 1950. Joseph Maudslay.
 2151. John Buchanan.
 2257. Charles Renshaw.
 2341. William Nehemiah Parsson.
 2417. Richard Ford Sturges.
 2639. Henry Bessemer.
 2707. George P'ye.
 2731. John Jones and Edward Jones.
 2749. William Morgan.
 2777. William Edward Laycock.
 2788. Charles Edwin Heinke.
 2796. Jacob Levi Elkin.
 2861. Frederic Siemens.

PATENTS ON WHICH THE THIRD YEAR'S STAMP DUTY HAS BEEN PAID.

January 19th.

142. Robert Angus Smith and Alexander McDougall.

January 20th.

150. Cyprien Marie Tessie du Motay.
 153. Peter Spence.
 183. John Bird.

226. Richard Garrett.
 251. Alfred Vincent Newton.

January 22nd.

162. John Lockart, Junr.
 190. Archibald Lockhart Reid.
 193. Thomas Wicksteed.
 194. Thomas Wicksteed.
 243. Rd. Archibald Brooman.

WEEKLY LIST OF DESIGNS FOR ARTICLES OF UTILITY REGISTERED.

No. in the Register.	Date of Registration.	Title.	Proprietors' Name.	Address.
3938	Jan. 23.	Improved Buckle	Charles Rowley and Co.....	{ Birmingham, London, and Manchester. 88, Piccadilly.
3939	„ 24.	Turnover Collar.....	Arthur Newman Dare	